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Tests of Some Joints Used in Heavy Timber Framing

By H. D. Dewell*

SYNOPSIS—Reports results of tests on timber joints covering nearly the whole range of heavy timber framing: tests of pin-keyed joints of 6x6 and 12x12 timbers, with capacities of 60,000 to 180,000 lb.; tests of lag-screwed and bolted joints; and tests of washers. The pin-keyed joint is used extensively in framing the Panama-Pacific exposition buildings. The Hawaiian hardwood Ohia is the best material for the pin-keys.

While timber is the earliest and still the commonest material used in framing, information on the strength of its various joints is very meager. It is true that the same principles of design that hold for steel and reinforced concrete hold equally well for timber construction, yet the lack of uniformity of the structure of timber and its different resistances to forces applied in various ways make it necessary to substantiate the assumptions ordinarily made in design by tests on actual details.

It is the purpose of this article to publish the results of:

1. Tests made on timber joints that are being used in the framing of the Panama-Pacific International Exposition;

2. Tests to determine the strength of bolted timber joints.

3. Tests on the efficiency of the standard cast-iron washer when used with Douglas fir;

The tests under (1) were made under the direction of the writer. The tests under (2) were made by E. E. Adams, Assoc. M. Am. Soc. C. E., now Consulting Engineer for the Union Pacific System, and were published in the "California Journal of Technology," September, 1904. The tests under (3) were made as thesis work for graduation in the University of California in 1904, by

*Chief Structural Engineer, Panama-Pacific International Exposition, San Francisco, Calif.

Fig. 1. Joints Keyed with White-Oak and Gas-Pipe Pins; After Test to Failure

Frederick L. Bixby (now Professor of Civil Engineering in the New Mexico College of Agriculture and Mechanical Arts). Prof. Bixby has very kindly given the writer permission to here publish the results of his thesis.

All the tests described in this article were made at the civil engineering laboratory of the University of California. Reference is also made, however, to a few tests on another form of timber joint made at the Massachusetts Institute of Technology.

Tests of Pin-Keyed Joints

The main series of tests was made on pin-keyed joints according to the drawing, Fig. 2. Such joints are intended for splicing tension members in trusses, or for fastening bolsters on columns to receive the ends of trusses, girders or kneebraces. The resistance of the joint involves several elements: Strength of circular pins in shear; resistance of pins to distortion; bearing value of timber, both against and across the grain; and strength of bolts in tension.

The joint is not a new one, having been used extensively in the framing of previous exposition buildings, as

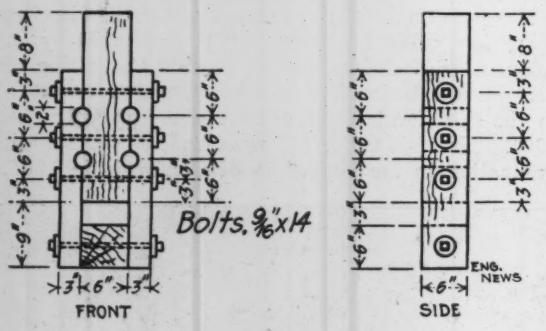


Fig. 2. Details of Pin-Keyed Joint Used in Main Series of Tests

described in Engineering News, 1904. It has certain obvious advantages over some of the many splice joints which are in general use in timber framing. It does not depend in its action upon difficult and expensive cuts and daps of the timber, nor upon the resistance of bolts in bending. It is much cheaper than the joint of steel fishplates with riveted lugs, and is more certain in its action, since equal bearing is more easily secured on the several pins than on the different lugs of the fishplate joint.

The method of framing is as follows: Two splice pads are spiked on the sides of the main timber to be spliced. The bolt-holes are bored, the bolts driven and the nuts screwed up. The holes for the circular pins are then bored, and the pins driven in. A close fit for all pins is thus assured, with a minimum amount of labor; with average inspection, the action of the joint can be depended upon.

Reason for Tests—The question of the distribution of the stresses in this joint, and the safe values to be used in the design, led to the tests described. In the Louisiana Purchase Exposition at St. Louis, and the Pan-American Exposition at Buffalo, the pins used were white oak, 2-in. diameter. From the article in Engineering News referred to above, it is found that the joints were designed for a value in shear on the oak of 400 lb. per sq.in., and a total tension in the bolts equal to

TABLE A. STRENGTH OF OHIA WOOD (OHIA LEHUA)

	Average strength, lb. per sq.in.
Static-bending (4 tests)	
Elastic limit	7,010
Modulus of rupture	13,770
Modulus of elasticity	1,914,000
Impact-bending (2 tests)	
Elastic limit	13,285
Modulus of elasticity	1,974,000
Compression parallel to grain (5 tests)	
Elastic limit	3,783
Crushing strength	5,543
Modulus of elasticity	2,574,000
Compression at right angles to grain (6 tests)	
Elastic limit	1,951
Shear parallel to grain (12 tests)	
Shearing strength	1,586

TABLE B. STRENGTH OF AUSTRALIAN HICKORY (SPOTTED BLUE GUM)

	Strength, lb. per sq.in.
Modulus of rupture in transverse bending (specimen 4x6 in., 54-in. span)	15,300
Tensile strength	16,300
Compressive strength (specimen 3x3x12 in.)	8,500
Shearing strength (specimen 6x6x2 in.)	1,700

one-half the total stress in the member spliced. Were the pin placed to take shear across the grain, its value would be considerably in excess of the above figures, but were it placed so that it would shear with the grain, its safety factor on its ultimate value would not be over 2, the ultimate value of white oak in shear with the grain being about 800 lb. per sq.in. It would hardly be safe to trust that all the pins used could be placed to take shear only across the grain, even with the best inspection.

It was this consideration which led to this series of tests, i.e., to find a material to be used for pins which would furnish a resistance equivalent to a value of 400 lb. per sq.in. in shearing on the diametral surface of the pin, with a safety factor of at least 2 on the yield-point, and at the same time be cheaper than a pin of solid iron.

The assumption that the bolts in the joint are stressed in tension by an amount equal to one-half the load on the joint would be correct did the wood offer equal resistance to stress in any direction. But as timber has a different resistance to crushing with and across the grain, and as there are two materials in the joint, as oak and pine, or metal and pine, this assumption may not hold true, though it may be on the side of safety. The only treatment of a problem similar to this of which the writer is aware is given in Prof. Jacoby's "Structural Details," Design of Heavy Framing, Art. 23.

Kinds of Pin Tested

In the present tests the following materials were used for pins: Ordinary gas pipe, white oak, Hawaiian Ohia, Australian hickory or spotted blue gum, full-weight steel pipe, extra-heavy hydraulic steel pipe, and pins of solid steel. These materials need no special mention except the Ohia wood and the Australian hickory.

Ohia is a timber grown only in the Hawaiian Islands. Its botanical name is *Ohia Lehu*. Table A* gives the reports of the Forest Service on tests of Ohia:

The fibers of this wood do not run parallel to each other but are more of a spiral growth. It is seen from the above table that the shearing strength of Ohia is approximately double that of white oak.

Australian Hickory is the trade name for spotted gum. The data relating to its strength given in Table B are taken from a trade publication, and the correctness of the data cannot be vouched for:

*From a letter from E. O. Faulkener, Manager of the Tie and Timber Department of the Atchison, Topeka & Santa Fé Railway System.

Tests with White-Oak and Gas-Pipe Pins

The first set of tests was made on joints having pins of white-oak and gas-pipe. The results are summarized in Table I. No attempt was made to measure either the stress in the bolts or the distortion per increment of load. Fig. 1 shows a photograph of the joints after failure.

A variety of washers were used on the joints, and it would appear that a greater load could have been taken by the joints had they been fitted with larger washers. This subject will be referred to later.

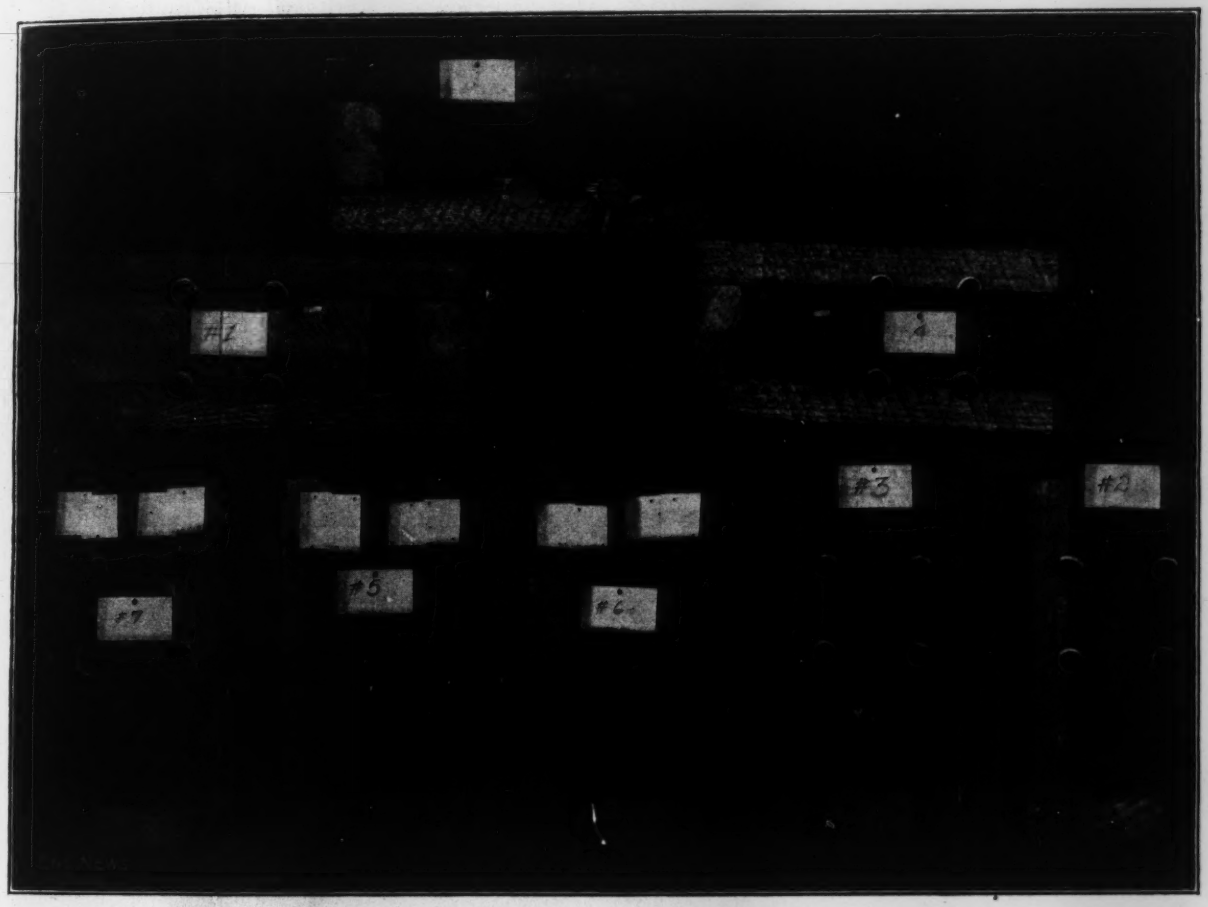


Fig. 3. Joints Keyed with Solid- and Hollow-Steel Pins and Pins of Ohia-Wood; after Test to Failure

TABLE I. TESTS OF PIN-KEYED JOINTS WITH WHITE-OAK AND GAS-PIPE PINS

No. of test	Kind of pin	Load at first marked distortion, lb.	Ultimate load lb.
1	1¼-in. gas pipe	24,000	49,800
2	2-in. oak	30,000	52,600
3	1¼-in. gas pipe	28,000	45,600
4	1¼-in. gas pipe	26,000	44,400
5	2-in. oak	26,000	51,300
6	2-in. oak	24,000	52,750

Note:—In all these joints, failure occurred by shearing of the oak keys, and distortion of the pipe keys with splitting at the seams of the pipe. The slip of the joint at the load of first distortion was about $\frac{1}{16}$ in. After the failure of the pins, the slip gradually increased, the joint failing by bending of the bolts and crushing of the timber under the washers; a maximum slip of about ¾ in. was reached at the ultimate load.

Tests with Solid and Hollow Steel Pins and Ohia-Wood Pins

In the second set of tests the pins were full-weight and extra-heavy pipe (called hollow steel pins), solid steel rounds and Ohia wood. The washers on the bolts varied somewhat in size, as in the previous set.

The results are given in Table II. Fig. 3 shows the appearance of the joints after failure.

In this set, the tension in the middle bolt of each joint was measured by determining its increase in length with two micrometers reading to 0.0001 in. These micrometers were held opposite the ends of the bolt in a rigid iron frame which was so attached to the joint as to be unaffected by any give in the joint. For computations, the gage-length was taken as that between inner sides of washers, and the modulus of elasticity as 28,000,000 lb. per sq.in. The computed values of the tension in the bolts are probably slightly low, as any bending in the bolt decreases the distance between the ends.

One of the bolts tested in tension, separately, showed a yield-point of 40,800 lb. per sq.in., and a maximum strength of 53,500 lb. per sq.in. A few of the results for tension in the bolts appear higher than this maximum. These abnormal results may be accounted for by the fact that the ends of the bolts were uneven, and, after the joint began to slip, the bolts took some bending, causing the micrometer contact point to move over the ends of the bolts.

In the tests of Joints 5, 6, 7 and 8, a cardboard was tacked across the line of splice, a scale reading to 0.01

TABLE II. TESTS OF PIN-KEYED JOINTS WITH HEAVY PIPE, SOLID STEEL AND OHIA-WOOD PINS

F. W. pipe = pins of full-weight pipe; E. H. pipe = pins of extra-heavy pipe; steel = solid steel pins; Ohia = Ohia-wood pins. All joints had 4 pins 2 in. diameter by 6 in. long; bolts $\frac{7}{8}$ in. x 14 in.; washers 2½-in., 2½ in. (joint 4), and 1¾ in. (joints 2 and 6). Bolt tension was gaged on 12¼ in. length.

Joint No.	Loads, lb. (slip, in.) [Bolt tension, lb. per sq.in.]			Max. load	Remarks
1 E.H. pipe	21,400 ($\frac{1}{16}$) [51,800]	35,000 ($\frac{1}{8}$) [48,400]	48,000 ($\frac{3}{16}$) [3,120]	53,400	Crushing at pins. Pipe only slightly distorted. Joint opened ¼ in. at ends. No shear failure in main member or splices. One splice splice poor, and this side apparently weak.
2 F.W. pipe	24,000 (first slip)	35,000 ($\frac{1}{16}$) [20,300]	46,600 ($\frac{3}{16}$) [48,800]	47,900	Pipes crushed. Both splices split at ends. No shear failure. Washers buried in wood due to lateral expansion. One pipe distorted at 43,600 lb. load.
3 E.H. pipe	33,450 ($\frac{1}{32}$) [3,800]	45,000 ($\frac{1}{16}$) [10,300]	55,700 ($\frac{3}{16}$)	59,600 ($\frac{1}{4}$)	Crushing at pins. Both splices split at ends. No shear failure. Only slight distortion of pipes. Crack heard at 33,450 lb. load.
4 F.W. pipe	30,000 ($\frac{1}{32}$) [5,500]	39,000 ($\frac{1}{16}$)	45,000 (0.15)	46,000 ($\frac{1}{4}$)	Crushing at pins, and slight distortion in 3 pipes. Both splices split at ends. No shear failure. Washers (2½-in.) buried in wood. Crack heard at 40,000 lb. load.
5 Sol. steel	30,000 (0.03) [9,600]	45,800 (0.05) [17,700]		58,400 (0.35)	Crushing at pins. One splice cracked at end. No shear failure. First crack heard at 39,000 lb. load. Wood failing at 56,800 lb. load.
6 Sol. steel	20,000 (0.01) [2,800]	35,000 (0.03) [9,500]	50,000 (0.06) [17,500]	61,900 (0.25)	Crushing at pins. Both splices split at ends. No shear failure. First crack heard at 40,000 lb. load. Lateral separation at 60,000 lb. load.
7 Ohia	30,000 (0.03) [9,500]	40,000 (0.05) [21,400]	56,800 (0.10) [67,300]	68,100 (0.40)	Little or no distortion of pins. Lateral separation began at 62,600 lb. load.
8 Ohia	30,000 (0.01) [9,500]	40,000 (0.02) [14,200]	60,000 (0.10) [53,200]	66,000 (0.35)	One pin split. Crushing at pins. Both splices split at top. Shear failure in splices between pin-holes. Splices were of unequal length; poor bearing at base. Sudden give at 59,000 lb. load. Lateral separation at 62,600 lb.

TABLE III. TESTS OF JOINTS WITH DEFECTIVE OHIA PINS

Joint	Each joint, 6 pins 2 in. diameter by 12 in. long: Load, lb. (slip, in.)			Max. load	Remarks
A	60,000 (0.01)	100,000 (0.07)	140,000 (0.19)	158,000 (0.56) (0.36 on release of load)	Both splices originally checked in center. Both splices opened up along checks. Four pins cracked, one of these being completely sheared at end. First crack heard at 90,000 lb. load.
B	60,000 (0.01)	100,000 (0.09)	140,000 (0.21)	163,000 (0.49) (0.32 on release of load)	One splice originally checked. Splices not cracked by test. Three pins cracked. First crack heard at 130,000 lb. load.

in. marked thereon, the cardboard cut on the line of splice, and the deflection for increments in load of 5000 lb. noted.

As will be seen from Table II, Joints 1 and 2 failed by distortion of the pins; 3 and 4, by combined failure of the wood and pin; 5 and 6, by failure of the wood at

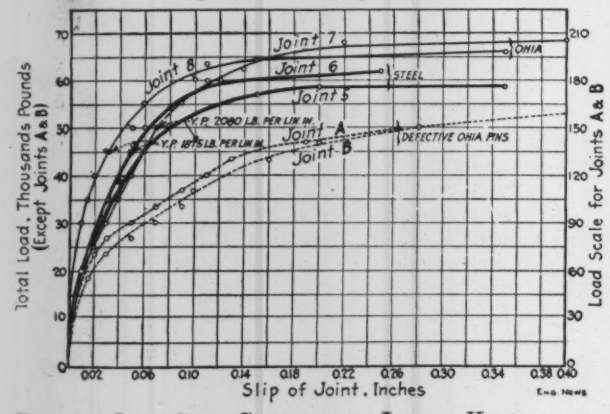


FIG. 4. LOAD-SLIP CURVES FOR JOINTS KEYED WITH SOLID-STEEL AND OHIA-WOOD PINS

(Curves for two joints with imperfect Ohia keys are shown by dotted lines. The vertical scales for total load differ for full and dotted lines, but for load per inch of pin the curves all have the same scale.)

no higher values than 3 and 4; while Joints 7 and 8 (Ohia pins) gave the highest values of any. The joints with the solid steel pins were no stronger than those with the extra-heavy pipe. The explanation of the high values of the Joints 7 and 8 is that the Ohia pins distorted just enough to distribute the pressure more uniformly over the timber, the two materials being more nearly of the same hardness than timber and steel.

The relation between the load on the joint and the slip is plotted for Joints 5 to 8 in Fig. 4, which also includes curves for two joints with imperfect pins, noted farther on. The ratio between total tension in the bolts and total load on the joint is plotted in Fig. 5. The values for total tension in the bolts were calculated on the assumption that all bolts took equal stress simultaneously. This assumption is probably not strictly true, and would explain in part the erratic values of the ratio.

It would appear from these curves that the joint was proportioned about right, since the assumption that the tension in the bolts is equal to one-half the stress in the splice appears to be nearly true for the strength of the joint at the yield-point. Values of bolt-stress higher than one-half of the total load on the joint are undoubt-

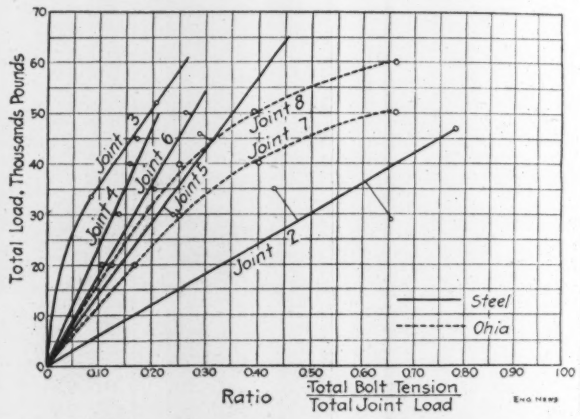


FIG. 5. VARIATION OF RATIO OF BOLT TENSION TO LOAD ON JOINT

edly due to the bolts taking appreciable bending after the yield-point of the joint has been reached.

With washers of larger diameter, the ultimate strength of the joint would probably be considerably increased, although its yield-point would perhaps not be raised to any great degree.

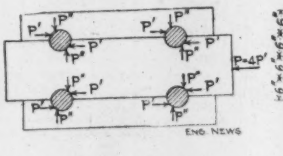


FIG. 6.

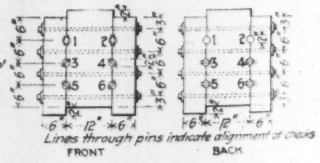


FIG. 7.

Fig. 6. Sketch Showing Pin Pressures in Pin-Keyed Joints.
Fig. 7. Test-Joints Made Up with Defective Ohia Pins.
(Note that in Fig. 7 the joint-timbers are wider than in Fig. 1 and have six pins.)

The pins in the tests of this paper were acted upon by forces not in the same plane, thereby causing a moment to be exerted on each pin. Fig. 6 shows the different forces and their lines of application. It is evident that these lines of application as well as the forces themselves vary as the load on the joint varies. The angle between resultant pin-pressure and axis of joint varied from 20° to 29°, instead of 15½° as given by Prof. Jacoby, although it must be remembered that Prof. Jacoby's measurement was for the case of a pin bearing parallel to the fibers against a single stick while here the pressure is in opposite directions on each of two quadrants, these two quadrants separating as the pressure is applied on the joint.

Recommended Design—From the results of the above tests, it was decided to design joints of this kind for a working value of 800 lb. per lin.in. of 2-in. pin, either of Ohia or of extra-heavy pipe, with enough bolts to take a stress (at 16,000 lb. per sq.in.) equal to one-half the total stress to be transmitted by the joint, the pins and bolts to be spaced 6 in. on centers.

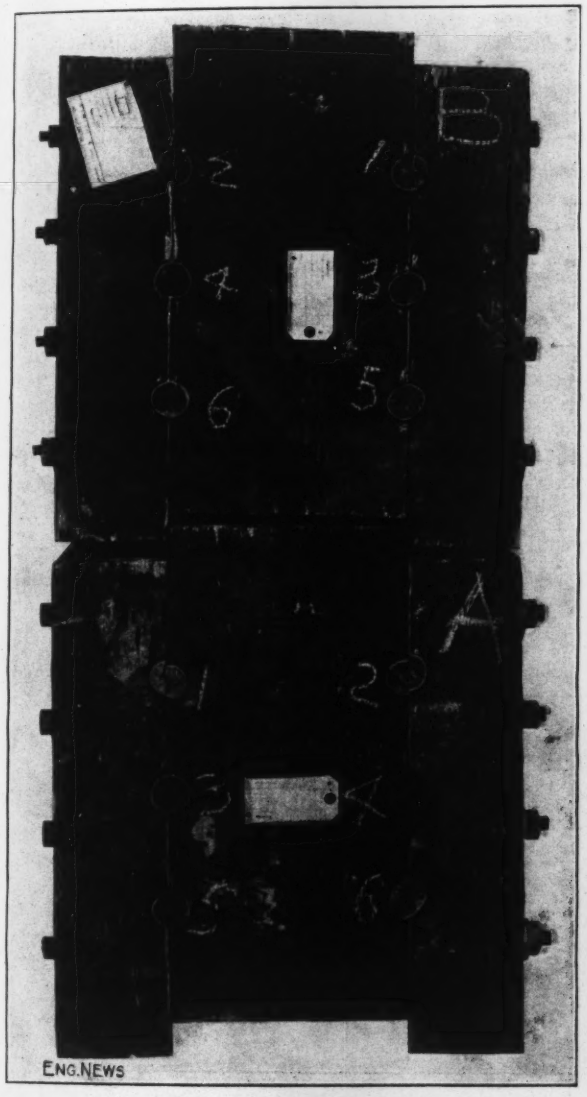


Fig. 8. Joint Made Up with Defective Ohia Pins; after Test to Failure

Tests with Defective Pins

The Ohia pins used in the tests of Tables I and II were samples furnished by the manufacturers, and were lathe-turned. It was found after contracts were let for the buildings that some of the pins furnished were not up to the standard of the samples. All were run through a sticker, instead of being turned, and consequently some were not truly circular. Again, due to the loss of the mill in the Hawaiian Islands, and consequent use of old

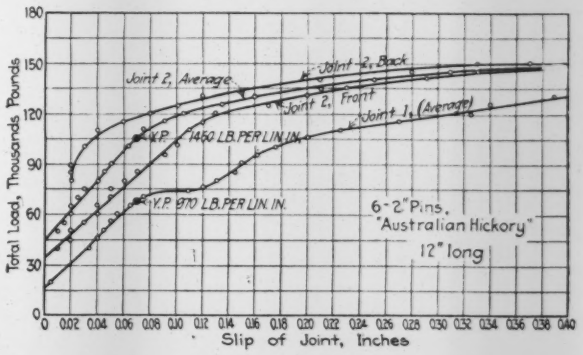

Total Load, Thousands Pounds
Slip of Joint, Inches
Joint 2, Average
Joint 2, Back
Joint 2, Front
Joint 1, (Average)
Y.P. 1450 LB. PER LIN. IN.
Y.P. 970 LB. PER LIN. IN.
6-2" Pins, "Australian Hickory" 12" long

Fig. 9. Load-Slip Curves for Joints Keyed with "Australian Hickory" Pins
(Joints poorly framed.)

stock, many of the pins first delivered were of old stock and were very badly season-checked. In actual construction, the piles of pins are carefully gone over by inspectors and any pins season-checked to any extent, or not circular, are rejected. However, to find what effect the poor pins would have on a joint, if any should manage to get in, two joints were made up as shown in Fig. 7 and tested to failure. These joints were twice as wide as those of the main series, and had six pins instead of four. No measurements were made to determine the tension in the bolts, but the slip of the joints at successive increments of load was measured.

The results are shown in Table III. The relation of slip to load is shown by the dotted curves in Fig. 4, which bring out the great increase of slip produced by the pin defects. The ultimate strength of the joint should have been about 198,000 lb. There is seen to have been a falling off in ultimate strength and also in yield-point. The lower efficiency of the joint per lineal inch of pin is undoubtedly due primarily to the poorer quality of pin. Any deviation in the cross-section of the pin from a true circle will unquestionably reduce its value to transmit stress. It is possible also that with an increase in the number of pins the average efficiency of a pin is lowered.

However, for the working value of the joint as used in design, 57,600 lb., there is no appreciable slip (about 0.01 in.), and a factor of safety on the yield-point of about 2.

Fig. 8 shows the appearance of the joints after testing. The poorer quality of the pins as compared to those of the prior tests is well shown.

Tests with "Australian Hickory" Pins

Two tests were made on joints like those last mentioned (Fig. 7), but with "Australian hickory" pins. These pins were manufacturers' samples, furnished with the view to substituting them for the Ohia pins. They

were run through the sticker, not turned, and therefore were not exactly circular. The joints were framed by one of the contractors of the buildings, and were poorly done. Joint 1 was especially bad, the holes for the pins having been bored from two sides. There were openings $\frac{1}{16}$ to $\frac{3}{16}$ in. wide at some points of the periphery of each end of each pin.

The test results are represented by curves in Fig. 9.

(*To be concluded*)

Reconstruction of the Mississippi River Levee at Helena, Ark.

A history of the levee along the southern river front of the city of Helena, Ark., and the destructive effects of the dry-weather slips of last fall were given in ENGINEERING NEWS, Nov. 20, 1913, p. 1014. As stated in the conclusion of that article, the officials in charge decided to build the new levee farther back from the river on a new site.

The new levee is being constructed as shown in the accompanying cut by dumping loose earth from a 20-ft. trestle, the embankment being built up as the material falls from the cars. There appears to be no provision for compacting, layer construction, or sorting of the material.

The reason given for this method of construction, we understand, is the necessity for completing the work before the coming spring floods. The trestle extends back to the borrow pit in the hills, about 3000 ft. away, so that with the use of four full-sized locomotives and trains of dump-cars the work has progressed very rapidly—quite possibly too rapidly for the safety of the fill when water comes against it.

The levee is being built by the Helena Improvement District, a local body over which the Federal Mississippi River Commission has no jurisdiction, we are informed by our correspondent.

When one reads of levees in the Mississippi Valley failing when exposed to extreme flood, it is instructive to an engineer at least to know how some of these levees are constructed.

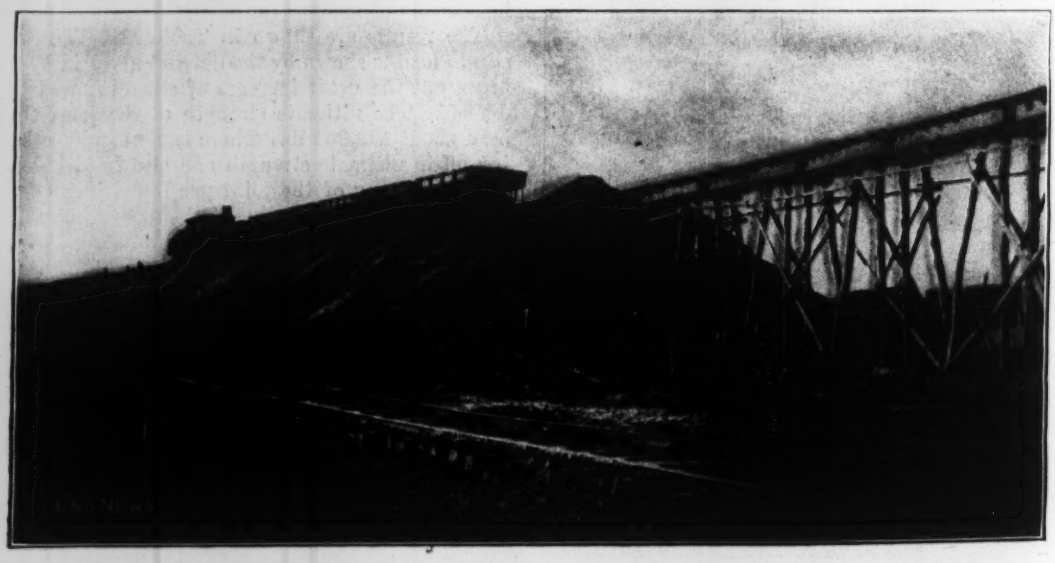
[Proof of the above was sent to C. H. Purvis, Engineer of the Helena Improvement District, from whom we received the following communication.—ED.]

Sir—Your article says: "There appears to be no provision made for compacting, layer construction or sorting of the material." To the thoughtless and inexperienced this is apparently true. As a matter of fact it is not. I have been building levees for 30 years and can say absolutely without fear of any intelligent contradiction that *water* against levees is the only agent that ever compacts them and the only one that it is practicable to use.

This method of compacting is provided for by adding to the desired net fill a percentage varying from 10 to 25%, as the soil may indicate; thus insuring the required grade when the inevitable shrinkage has taken place. All specifications for levees that I have seen of late years require that the levee shall be begun at slope stakes and built up in 3-ft. layers. This clause has come down from wheelbarrow days; and I think that I am the author of it. Its object was not to stop *leaking*, but that the shrinkage might be uniform.

The weight of the embankment above the water-soaked earth of the base closes any interstices that may exist as the water rises. In some few places where a stiff gumbo soil is encountered, which will practically mold itself into the shape of the conveyor, be it scraper or wagon, the building by layer tends to weld the lumps together. But, no matter how built, no one has ever seen a levee made of any material other than rock or pure sand that did not shrink when the water came against it.

However, a part of this levee was built as your writer says, "by dumping from a trestle," and I believe that that part, except for a few inches of rollover, is more thoroughly compacted than it would be had it been made in 3-ft. layers by teams; and for this reason, the



CONSTRUCTING THE NEW MISSISSIPPI RIVER LEVEE AT HELENA, ARK., BY DUMPING FROM RAILROAD TRESTLE

cars held about 12 to 15 cu.yd., and with practically 90 % of the load falling *en masse,* a mean distance of more than 10 ft., more pressure was exerted on the embankment beneath, than would have resulted from the pressure of a few teams over it. (We all know, who have looked, that only a few inches of a long used road is packed much harder than the surrounding ground; never is the pressure felt to a depth of 3 ft.) If we are depending on 3-ft. layers to give stability to our levee structures and to prevent leaking, we must seek a more powerful hammer than the hoof of a mule and the wheel of a scraper.

I can further state that there is absolutely no instance where a levee on the Mississippi River has failed because it was not built in layers and the material sorted. They have failed solely because they were too small to do the work required of them. However, many that have failed would possibly have stood a little longer, had there been proper precautions taken in securing a proper foundation upon which to start the 3-ft. layer.

In the levee in question, the entire base of 170 ft. in width was excavated to a depth of from 2 to 4 ft., and the material wasted; there were then dug four longitudinal ditches for the purpose of further exploration, and any foreign substance disclosed was followed and taken out. These ditches were refilled with good earth and properly tamped, not in 3-ft. layers, but a shovelful at a time.

After dumping from a trestle and completing the small core to close the break, or line of defense, which we thought it was absolutely necessary to do as quickly as possible, as 42 ft. on the local gage would put water through the break, the superstructure of the trestle was removed and a track built on top of the embankment to supply teams with earth, with which to build the front slope. Another track was laid to build the rear slope and banquette. In this way, teams and railroad tracks have been nearly all through and over this levee and banquette.

There is an allowance of 15% for shrinkage. I do not look for anything like this amount, and I think the net dimensions when all shrinkage, natural and artificial, has been completed, will be ample to withstand any flood which may come against it. The net dimensions are: grade 5 ft. above the highest water, 10-ft. crown, sloped 3 on 1; reinforced by banquette with grade 3 ft. below highwater, 40-ft. crown, slope 3 on 1.

It must not be understood that anything I have written implies that the usual specifications for layer construction and compaction are unnecessary or useless; but like all rules and regulations, unless used with a liberal allowance of common sense, at times, become ridiculous. Nor have real levee engineers built levees too small through error in judgment or knowledge; but from the political inability of Congress to comprehend the real value to the nation of the protection of the Mississippi Valley and the vain efforts of the inhabitants to find by costly experiment the smallest levee that would protect.

C. H. Purvis,
Engineer, Helena Improvement District.
Helena, Ark., March 3, 1914.

A Motor Truck on Runners

Motor-vehicle transportation was practically powerless in a few Eastern cities during the recent heavy snowfalls. How one concern overcame its difficulties is shown by the accompanying figure. This shows a tractor and trailer combination with runners under the trailer wheels and also one under the single steering wheel of the tractor. This scheme was put into service by the Knox Automobile Co., of Springfield, Mass., from whom the photograph was received.

Motor Tractor with Runners for Deep Snow

Plans for a Standard-Gage, Heavy Electric Railway between Madrid, Spain, and the French frontier, have been ordered prepared by the Spanish Ministry of Commerce according to press dispatches. The official gage of the principal Spanish railways has ritherto, for strategical reasons, differed from that of France, causing much inconvenience to passengers and to the Spanish commerce generally. It is calculated that the new double-track railway will reduce the time occupied for the journey from 13 hours to 7: and the time of the journey between Madrid and Paris from 27½ hours (best time at present) to 20 hours.

Special Features of a Concrete Building

The new assembling and service building for the automobile business of the Ford Motor Co., at Chicago, presents some unusual and interesting features in its design. The building has a 164-ft. front on 39th St. and extends south on Wabash Ave. 232 ft., with a provision for a further extension to a length of 460 ft. It is six stories high, without basement. The building has reinforced-concrete columns, floors and roof. Except on the alley side, no outside concrete is exposed, the exterior being of brick, terra-cotta and glass. The proportion of window area is large, in accordance with modern factory construction, and makes up about 60% of the exterior.

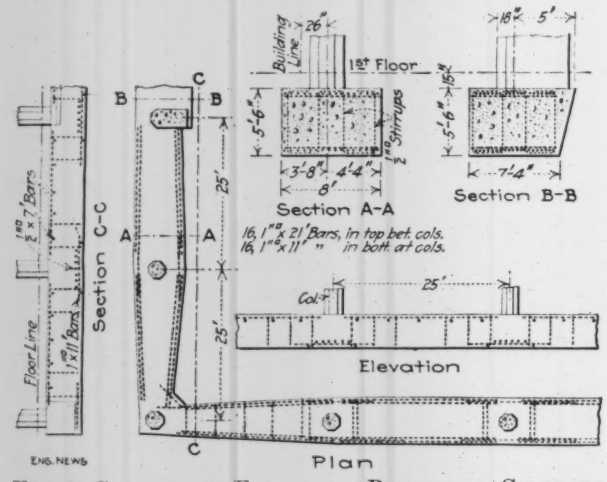


FIG. 1. CONTINUOUS FOOTING OF REINFORCED-CONCRETE BUILDING FOR THE FORD CO., AT CHICAGO

The building rests on a deep bed of sand. As the property is surrounded on three sides by streets and on one side by an alley, there is little danger of the foundations being undermined by adjacent excavations. The foundations are all spread footings designed for a soil pressure of 3500 lb. per sq.ft., including the percentage of the live-load required by the Chicago building code. [illegible] footings under the wall columns on the street [illegible] form a continuous girder 5 ft. 6 in. deep and from 7 [illegible] to 8 ft. wide, Fig. 1. The widened portion [illegible] is to carry two intermediate columns one [illegible] high. The top of the footing is 15 in. below the first [illegible].

The column foundations on the alley side and also at the south end of the building are simple spread footings. The typical exterior footings are 14 ft. 3 in. square. Between the column footings on the alley side a 12-in. curtain wall of concrete was built for a depth of [illegible] 9 in. below and 3 ft. 6 in. above the first-floor line. The first floor is laid directly on the ground.

The footings at the south end of the building were designed for full panel loads in order to take care of the future loads that will come on these columns when the building is extended. The weight of the present south wall is now carried upon these footings, but when the building is extended this weight will be replaced by the weight of the floor construction extending to the next row of new columns. Between the footings at the south end of the building is a concrete curtain wall 13 in. wide and extending 4½ ft. below the first-floor level. This carries the weight of the 13-in. brick wall of the first story. The interior column foundations are stepped footings reinforced by two layers of steel bars placed near the bottom. The size of the bases varies from 13 ft. 6 in. to 17 ft. 9 in. square.

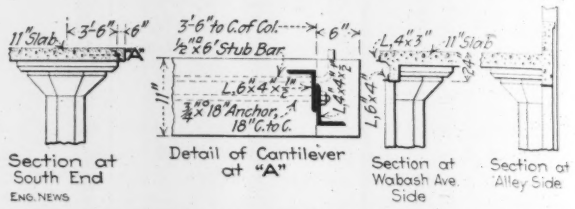

11" Slab
3'-6" to C. of Col.
½"ø x 6' Stub Bar
Section at South End
Detail of Cantilever at "A"
Section at Wabash Ave. Side
Section at Alley Side
ENG. NEWS

FIG. 2. COLUMN HEADS AND FLOOR SLABS, WITH DETAIL OF CANTILEVER EXTENSION AT SOUTH END

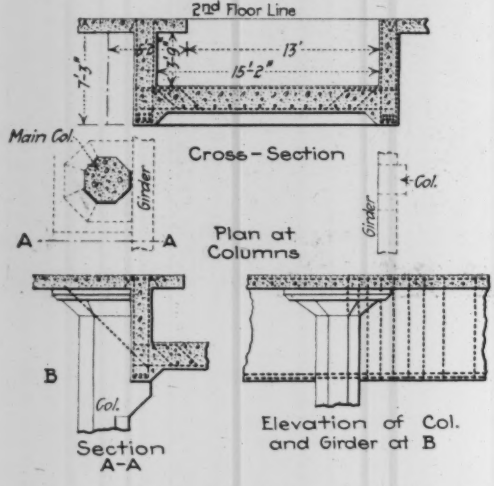


FIG. 3. REINFORCED-CONCRETE TROUGH OR BRIDGE CARRYING TRACK THROUGH BUILDING

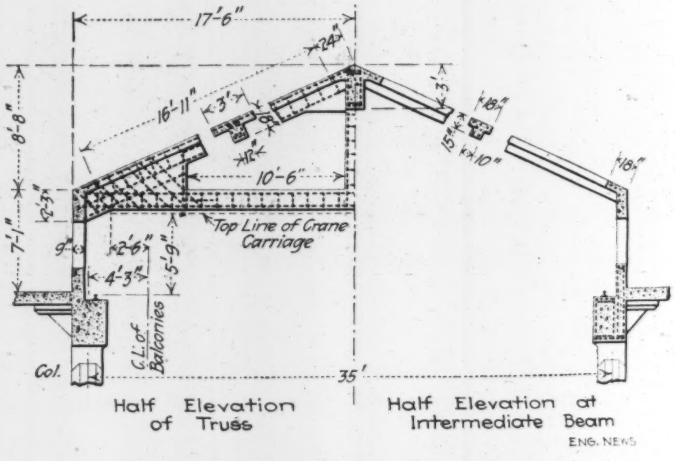


FIG. 5. REINFORCED-CONCRETE TRUSSES CARRYING MONITOR ROOF

The floors are of the Akme system of flat slab or beamless construction and are 11 in. thick. They are designed for a live-load of 150 lb. per sq.ft., with panels

28½ ft. c. to c. At the south end, the floor slabs extend 4 ft. beyond the center line of the columns. The temporary south wall is carried on cantilever extensions of the floors which are extended to this distance to provide for carrying the next panel of floor slabs when the building is lengthened. A pair of steel angles forming a Z-section is secured to the face of each floor slab by anchor bolts, thus forming a shelf to support the end of the future slab, as shown in Fig. 2. The angles are at present incased in concrete which has been cast separate from the general floor slab so that when the extension is made this concrete can be easily removed, leaving the steel shelf angle projecting.

A mezzanine floor covers a portion of one panel between the first and second floors. This is supported on two columns and suspended by four sets of hangers. Each hanger consists of two or three 1-in. round rods 11 ft. 8 in. long, with top and bottom bearing-plates made of 5-in. channels. These plates are embedded in the concrete of the mezzanine floor and the floor above.

The columns are all of octagonal section, varying from 40 in. to 24 in. outside diameter. The column capitals are also octagonal, with a flare of 45° from the vertical and a top diameter of 5 ft. 6 in. Above the flaring head is a column plate 7 ft. square by 9 in. thick, the lower edge of this plate being beveled. The columns are spaced 28 ft. c. to c. longitudinally and 25 ft. laterally, except that in the central bay of the building, where the railway track is supported, the columns are spaced 35 ft. c. to c., laterally.

There are no spandrel girders required in this floor construction but in some instances the concrete section has been dropped down a few inches below the ceiling along the wall to carry the terra-cotta trim for the exterior. The east, or alley wall of the building is made of concrete instead of brick, and on this side the concrete columns, floors and spandrel walls were cast integrally.

FIG. 4. TRACK GIRDER OF SECOND FLOOR CARRIED BY MAIN COLUMNS OF BUILDING

CONCRETE TRACK GIRDERS

The only girders in the building are those carrying the railway track, the crane runways and the monitor roof. The railway lines adjacent to the building are elevated, and a switch track runs through the building at such an elevation as to bring the car floors level with the second floor of the building. This track is in the central 35-ft. bay of the building and is carried in a concrete trough 16 ft. wide and about 5 ft. deep. The main track girders are 7 ft. 3 in. deep and 16 in. thick. Between these girders is a bottom slab 21 in. thick, carrying the track. One of

the main girders is carried on the main columns, while the parallel girder is carried on independent columns spaced 28 ft. c. to c. The second floor projects a short distance beyond one of the main track girders, thus providing a protected space under the overhanging floor for wires and heating pipes.

The track is laid with wood ties and stone ballast. The whole bridge structure is designed for Cooper's E-40 loading, with 25% added for impact, and the design is in accordance with the recommended practice of the American Railway Engineering Association. The construction is shown in Fig. 3, and Fig. 4 is a view of the

FIG. 6. INTERIOR OF FORD BUILDING, SHOWING CANTILEVER BALCONY FLOORS AND CONCRETE ROOF TRUSSES

first floor, showing at the left one of the heavy track girders supported on the main columns.

CONCRETE BALCONY FLOORS AND ROOF TRUSSES

In the central panel, 35 ft. wide, there is an open space from the second floor to the roof, except at the extreme north end where there is a floor panel 28x35 ft. at each floor. This open well or craneway is provided with an overhead bridge crane which runs the entire length of the building and serves all floors by means of cantilever balconies extending 8 ft. 6 in. from the column centers. These balconies are extensions of the floor slabs, and are of varying lengths; 14 ft. on the 6th floor, 38 ft. on the 5th floor, 42 ft. on the 4th floor, and 56 ft. on the 3rd floor. So there is always an open space 14 ft. long by 6 ft. 8 in. wide on each balcony from which to receive and deliver materials or automobiles from the bridge crane.

One of these 8½-ft. cantilever slabs 42 ft. long was tested with a uniform test load of 310 lb. per sq.ft., equal to 2600 lb. per lin.ft., in addition to weight of construction. Under this load the deflection was [illegible] at the outer edge, after the load had been on for 2[illegible].

Below the roof level the two central rows of columns carry the reinforced concrete longitudinal girders for the runway tracks of the bridge crane. Above these runway girders rise the side walls of the monitor roof. The roof is carried by reinforced-concrete trusses, having a span of 36 ft. and spaced 28 ft. apart. As shown in Fig. 5, these trusses are of the king-post type with a rise of 8 ft. 6 in. The bottom chords of the trusses are simply tie rods incased in concrete, but the section was made sufficiently strong to act as a beam to carry its own weight. The bottom chord and post are rectangular, while the upper chords are of T-section, 18 in. deep and 36 in. wide over the flanges.

The trusses are supported at the ends by the walls of the monitor roof, and are connected at the ridge by longitudinal T-girders 36 in. deep. The roof between each pair of trusses is supported by two intermediate rafters of T-section, dividing the area into three panels 7 ft. 4 in. by 16 ft. long on each side. Each of these panels is covered by a copper and glass skylight. At the north end of the building an arched concrete wall or girder replaces the concrete truss. This is 9 ft. deep at its ends and 14 ft. deep at the center, and is faced on the exterior with brick and terra-cotta.

Fig. 6 shows several of these special features of the building, being an interior view of the central craneway. Freight cars will be noticed standing on the depressed track, with car floors level with the second floor of the building. It will be seen that there is a wide unloading space on one side of the car and that the cantilever balconies on the opposite side overhang the cars slightly. This craneway or court will be inclosed entirely with steel sash and wire glass, with sliding doors opening from each floor onto the balconies.

CONSTRUCTION PLANT

During the construction of the building the concrete materials were brought in by cars on an elevated trestle and unloaded into storage bins south of the building site and beneath the track. From these bins the sand and gravel was delivered by means of a belt conveyor to elevated bins above the measuring boxes, which in turn were above the concrete mixer, so that measured quantities of gravel and sand were discharged into the mixer, together with the proper amount of cement and measured quantity of water for each batch. The 1-yd. mixer discharged the concrete into a 2-yd. hopper feeding a 1-yd. bucket in the elevator tower. The mixing plant and tower were located at the south end of the building. All of the concrete was spouted directly to the floor forms, except that the concrete for the monitor roof was placed by means of carts.

The spouting equipment presented some features of special interest which are shown in Fig. 7. In the first place, the chutes were rigid and self-supporting, so that there was no sagging in them. The chute consisted of a pair of 8-in. channels placed back to back, 12 in. apart, with bottom lacing and an interior trough of sheet steel. This formed a chord member that was trussed from beneath by struts and cables. The main chute extended from the receiving hopper at the top of the elevator tower to a shorter tower near the center of the building; from

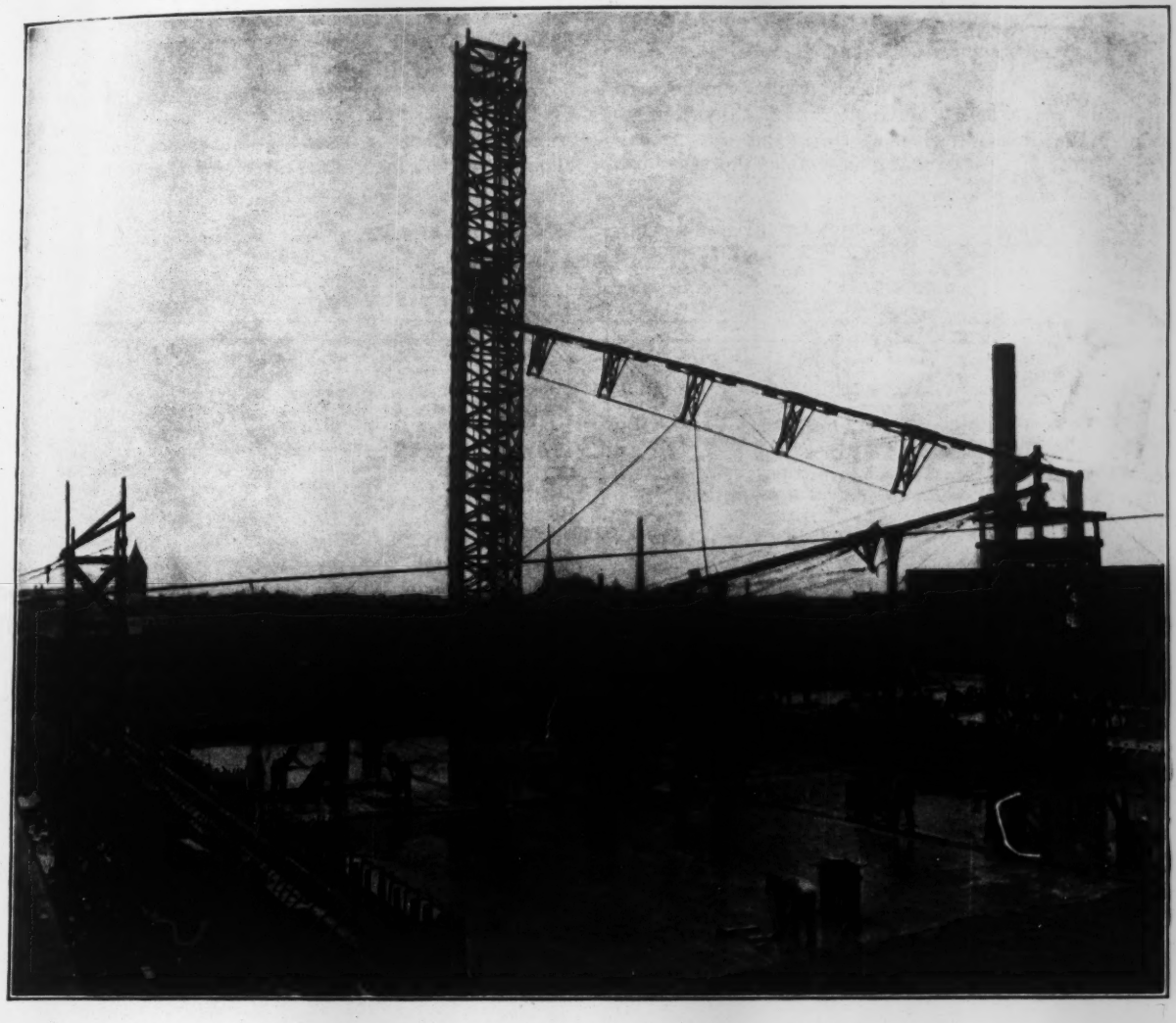


FIG. 7. CONCRETING PLANT AT THE FORD BUILDING, CHICAGO

(The special features are: 1, the rigid trussed chute; 2, the lower chute carried by a revolving horizontal steel boom; 3, the drop pipes on the lower chute.)

this second tower extended a second chute pivoted at the tower and supported by a latticed steel boom. The lower end of the boom was carried on a circular track around the tower, thus permitting the boom and chute to swing through a complete circle, reaching all parts of the floor.

An unusual feature was the use of flexible drop pipes, by which the concrete could be taken from several openings in the revolving chute and delivered to the forms. These vertical pipes were of metal, spaced 10 ft. apart and fitted with gates at the upper end which might be opened to draw off concrete from the chute.

The architect for the building was John Graham, of Detroit, supervising architect for the Ford Motor Co., and the structural design was made by the Condron Co., engineers, of Chicago. The general contractor was E. L. Schneidenhelm, of Chicago.

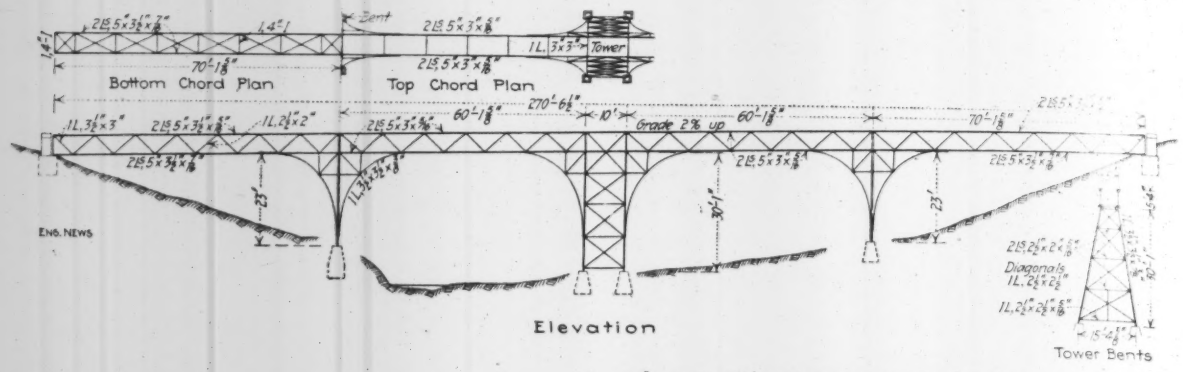
Enlarging the Suez Canal—In order to make the Suez Canal of sufficient depth to carry the largest ships now afloat work is now in progress toward deepening the canal to 40 ft. throughout its length. When the canal was opened in 1869 the width was 72 ft. and the depth about 26 ft. 2 in. The maximum permissible draft of ships using the canal in 1870 was 24.4 ft. In 1890 ships drawing 25.4 ft. were allowed and during the succeeding 24 years the increase has been at the average rate of about one foot every six years, thus bringing the maximum draft authorized now up to 29 ft. In June, 1913, the depth of 32 ft. 8 in. had been increased over a minimum width of 147 ft. 6 in. for a length of about 85 miles and over a width of 328 ft. for a length of 20 miles. Under the latest scheme a depth of 40 ft. throughout is to be made and a widening up to 197 ft. in the south section and the cutting of an appropriate number of sidings on the north and central sections where a minimum width of 147 ft. 6 in. is believed to be sufficient. The company has power to raise bonds up to $30,000,000 for this work, which it is expected will be completed by 1919.

Heretofore it has been the policy of the canal company not to offer a greater depth of water in the canal than is available in the port east of Suez. It is claimed that with the exception of Sydney, Australia, there is no eastern port which at low tide has a greater depth than that now provided in the canal throughout its full length, but the completion of the Panama Canal with its 40-ft. depth and the general increase of the Atlantic ports to carry boats of almost that draft has led the company to undertake this latest increase. The improvements are to be carried out by a dredging plant comprising 24 dredges of various types, representing over 16,000 hp., and having a capacity of about 10,000 cu.yd. per hr.

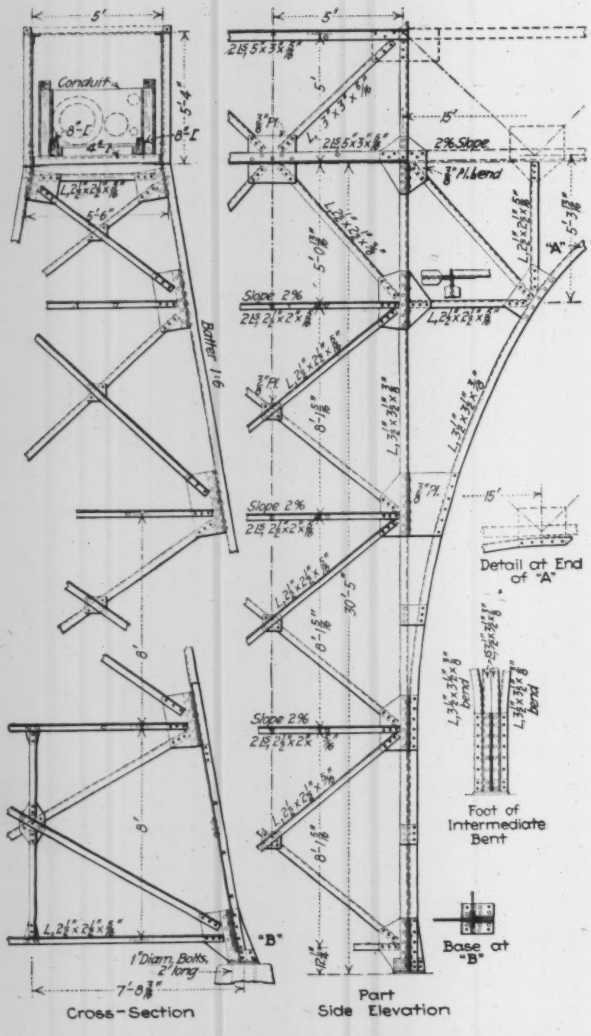
Steel Bridge to Carry Water Pipe over Pettibone Creek

A light steel bridge of special design which carries water and sewer mains of Great Lakes, Ill., across the ravine of Pettibone Creek is shown in the drawing herewith. While the construction is simple, the truss work being generally of single-angle construction, [illegible] general design is of novel outline.

The bridge, 270 ft. long, is carried by th[illegible] steel bents bolted to concrete foundations resting on s[illegible]day bottom. Its deck is 5 ft. wide. In the plane o[illegible] bottom chord of the trusses 4-in. 7½-lb. I-beams [illegible] placed at about 10-ft. spacing. These carry longitudina[illegible]m. chan-



nels supporting transverse wooden beams for the sewer and water main. The pipes are inclosed by boxing of two thicknesses of ⅞-in. lumber with 4-in. air space, and a layer of waterproofed paper on top.



PETTIBONE CREEK BRIDGE FOR SEWER AND WATER PIPES, GREAT LAKES, ILL.

The Ohio River Survey*

BY G. C. GRAETER†

Since August, 1911, the U. S. Engineer Department has been making a detail survey of the Ohio River. The completed survey will extend from Pittsburgh, Penn., to Cairo, Ill. At Pittsburgh it extends up the Monongahela River to Six-Mile Run and up the Allegheny River to a point near Millvale. The completed maps will show in detail the hydrography and the topography of both banks to a point in general ¼ mile distant from the tops of the immediate banks and in some cases to extreme flood level.

CONTROL-BASE LINE TRAVERSE

INSTRUMENT WORK—All instrument work on the primary traverse line has been done with a 10" transit-theodolite equipped with a high-power inverting telescope. All angles on stations in the main traverse line are repeated at least ten times, five times to the right and five times to the left. Both verniers of the fifth angles are read and recorded. The final angle used is that computed from the mean angle of the first set and the mean angle of the complement of the second set.

Observations on Polaris are made at about 10-mile intervals on the traverse. The azimuth of the line as run (corrected for convergence) is corrected to the azimuth obtained by observation. In the vicinity of Pittsburgh, owing to heavy fog and general unsatisfactory conditions, it was impossible to secure observations at elongation. Time observations were made at such periods as the star was visible; the computed azimuth from such observations checked very closely with the azimuth secured later by an observation at elongation.

TRAVERSE LINE—All courses of the traverse line are carefully measured with an adjusted steel tape 200 ft. long. The tape is leveled, as nearly as possible, by the chainmen and an 18-lb. pull is exerted by the head chainman. The temperature and time are recorded at the beginning of each course. All courses are corrected for temperature.

CLOSURE OF LINES—The traverse line is run in duplicate, one line on each bank. At intervals of about ten miles a closure is made to a degree of accuracy represented by 1 to 20,000.

PERMANENT MARKS—In each traverse line, permanent marks are established and witnessed at intervals of about one mile. The marks are cement-mortar pyramids, 6 in. square on base and 12 in. high to the truncated top. The top is 3 in. square, with a copper bolt in the center.

The pyramid is set about 3 ft. below ground surface and

*Abstract of a paper read at the annual meeting of the Indiana Engineering Society, at Indianapolis, Ind., in January.

†Vincennes, Ind.

surmounted by a 2-in. galvanized-iron pipe with a bolted cap top, which is appropriately marked. The latitude and longitude of these marks are computed from the notes of the traverse and the elevation of the bolt in the pyramids and of the top of cap is determined by wye-levels.

In addition to the permanent marks established by the base-line party, a larger benchmark is set by the level party, about every five miles of river distance. These benchmarks are set in towns, at lock sites, near the crest of bars, where the depth below normal pool is less than 11 ft., and at the mouth of each tributary stream where it is apparent any land will be flooded. These benchmarks have a large cement-mortar bedplate with copper bolt in center, surmounted by an iron pipe, with bolted cap top.

TOPOGRAPHY

All topography is taken by the transit and stadia method, traverses being closed on stations in the base-line traverse. All works of man and all natural features are located and sketches are made in the field. The topography is taken so that the ground surface from the low-water line of the river to the prescribed limits is shown by contours at vertical intervals of 5 ft. The allowed error of closure of topography circuits is approximately 10 ft. to the mile in distance two minutes in azimuth and 0.4 ft. in elevation. The actual closures average much better than the above. It has been found speedier and more convenient to reduce differences of elevation with a slide-rule. Correction is made for horizontal distance on all large angles.

Distances and vertical angles between instrument stations are read forward and backward.

LEVELS—All levels are run with ordinary wye levels. The elevations of all permanent marks of the base-line traverse are determined and new benchmarks are established, as described above under "permanent marks." The elevation of the water surface at each sounding range is determined, and a sufficient number of topography stations are leveled on to control the elevations of the topography traverse, in conjunction with the "permanent marks," which the topographers touch on.

A level line is run on each bank and these lines are closed into circuits. The allowed error of closure is five-hundredths times the square root of the distance run in miles, the actual average closure is nearer three-hundredths times the square root of the distance. All old benchmarks found are touched on, and furnished the control for the present line. Whenever possible "ties" are made with benchmarks of the U. S. Geological Survey, of cities and of railways. Mean tide at Sandy Hook, N. J., is used as datum.

HYDROGRAPHY

SOUNDINGS—The soundings are made on sections 1200 ft. apart, where the low-water channel depth is greater than 6 ft. On all bars where the channel depth is less than 6 ft., the ranges or sections are 600 ft. apart. Where the width of the river permits, the soundings are located by stadia by an instrumentman on shore. Range flags are set on each bank 600 ft., or 1200 ft. apart, as the case may be, and as directly opposite as possible. The range flags are consecutively numbered downstream and are carefully located by the topographers. The distance between range flags is paced. The instrumentman "sets up" behind a range flag, and reads and records the distance to a stadia rod, mounted in the bow of the sounding yawl, at the instant the sounding is taken.

The yawl is kept on line (between opposite range flags) by a flagman on shore. In wide stretches of river it has been found more satisfactory to locate soundings by "cut-off angles," as follows: The instrumentman selects a base line between two located points and reads and records angles to the sounding rod or lead line at the instant the sounding is taken, the yawl being kept on line between range flags by a flagman on shore. "Cut-off" angles should be kept under 45° from the base, thereby securing a better intersection for plotting on the range line.

The leadsman calls the depth of each sounding and if possible determines and calls the character of the material on the bottom to the recorder in the sounding yawl. Every fifth sounding is "flagged" by the yawl recorder and checked by the instrumentman, making a check between location and depth. Soundings are taken approximately 50 ft. apart. On the maps the bottom is indicated by elevation.

WATER MARKS—All reliable high-water marks are located and leveled upon, and if possible the date is secured. In many cities and towns the inhabitants have set appropriate marks at the crest level of each great flood, but in most rural districts accurate data are secured only by diligent inquiry.

The elevation of low water is shown at each variation of 0.1 ft. Previous surveys are relied upon for this information. Pool levels of constructed and proposed "located" dams are shown on the map by heavy broken lines. The elevations of all gages of importance are determined. A gage is set at the survey quarterboat at each "tie up" and the stages read and recorded. The elevation of the gage is determined by the levelman. A fairly accurate water slope may be figured from the data thus secured.

BORINGS—Wash borings are made where the depth below normal pool level of construction or located dams is less than 12 ft. Three borings are made on a cross-section of the river; one in the channel and one on each side of the channel boring and approximately 300 ft. from it. Each hole is sunk to a depth 15 ft. below pool level and a careful record of the material penetrated is kept. These borings are made with a drill operated by steam. The outfit is mounted on a light draft flat-boat.

The drill boat is approximately placed by a small steamboat and is dropped into position with anchored lines. During the operation of drilling the boat is held in position by anchored lines and attached spuds. Borings are located by transit and stadia. Wherever possible the boring data secured by the lock and dam surveys of 1909, 1910 and 1911 are utilized.

MAP

The survey is plotted by rectangular coördinates on a scale of 500 ft. to the inch. Lines of latitude and longitude for each one-minute difference are shown.

Pool levels are drawn in heavy broken lines. All works of man and all natural features are shown. Printed indications are used for cultivated land. The elevations and dates of reliable high-water marks are shown.

Borings are shown on the maps and a record of each hole is shown in the margin of the sheet on which the boring is located. Sheets are laid out and plotted so that adjacent sheets may be joined without break in the continuity of the map. The length and elevation of all navigable spans of bridges are given. Conventional signs are sparingly used in order not to cumber the map.

QUARTERS, SUBSISTENCE AND TRANSPORTATION

Field parties are housed on quarterboats. These are two-story boats containing accommodations for housing and subsisting 50 men. The lower story is divided into a kitchen, dining room, wash room and bunk rooms. The upper floor has an office, drafting room, bunk room and reading or rest room. It also contains a linen closet and space for field instruments.

The boats are screened and there is a screened porch on each end of the upper story. Bunks are built up, two-high, and are of sufficient size and correctly placed for ventilation, etc. Each man has a locker for personal belongings. The actual average cost of subsistence is slightly less than the allowed amount, which is 50c. per day per man.

Plenty of wholesome food is supplied. The quality of the food differs slightly according to the locality and local prices. Field parties carry lunches for the noon meal. The principal meal of the day is supper. Boiled water or water that is known to be pure is used for drinking purposes. Each field party is provided with a water keg (carried in the yawl) and with ice during hot weather. In cold weather a frying-pan and coffee pot are carried.

The field parties work from the quarter-boat. Parties working downstream from the boat row to work; parties working above the quarterboat are taken to work by a light-draft steamboat. At the close of the day's work the downstream parties are brought in by the steamboat and the parties above row in. The steamboat moves the quarterboat downstream as the work progresses, distributes and gathers the field parties and maneuvers the drill boat when necessary. Each field party has a yawl. A gasoline launch is used for running errands, securing mail, etc.

Abraham Lincoln Once a Surveyor—It appears that George Washington was not the only great American statesman who followed for a time the honorable calling of the surveyor. The editor of the "Bulletin" of the Engineers' Club of Philadelphia has resurrected the following:

Athens, November 4, 1834.

To the County Commissioner's Court for the County of Sangamon:

We, the undersigned, appointed to view and relocate part of the road between Sangamon town and the town of Athens, respectfully report that we have performed the duty of said appointment according to the law—and that we have made the said relocation on good ground—and believe the same to be necessary and proper.

JAMES STROWBRIDGE,
LEVI CANTRALL,
A. LINCOLN.

Here is the map—the Court may allow me the following charges if they think proper:

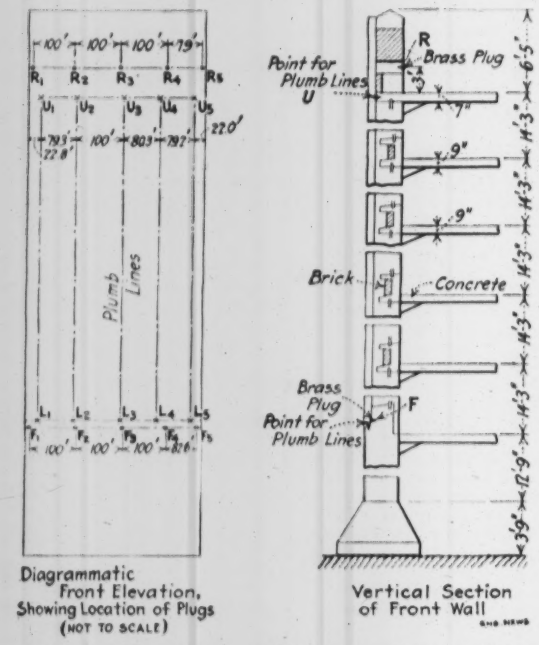
1 day's labor as surveyor	$3.00	
Making map	.50	$3.50

ABRAHAM LINCOLN.

Temperature Measurements on a Concrete Building*

Measurements to determine the possible expansion or contraction of a long reinforced-concrete building under marked changes in temperature have been made during the past few months on the 5-story Gray & Davis building, at Cambridge, Mass. The engineers of the building were Monks & Johnson, of Boston, and the contractor, the Aberthaw Construction Co., also of Boston. The measurements were made for and under the direction of the contractor, by Prof. John W. Howard, of the Massachusetts Institute of Technology.

The building is about 381 ft. long by 60 ft. wide, the floors being of the girderless type. It has no expansion joints. There is a tapestry brick veneer on the corner bays, and also on the curtain walls below the windows on the different floors. Construction was started in this



LOCATION OF MEASUREMENT PLUGS ON CONCRETE BUILDING TO DETERMINE TEMPERATURE MOVEMENT

building early in March, 1913; the first concrete above the paving being poured about April 9. The roof was poured complete about June 1. The foundations of the building were carried down through a layer of peat and mud of 12 to 15 ft. in depth to an underlying stratum of good coarse gravel.

Three separate sets of measurements were taken all along one front of the building; one to determine the variation in an established length along the water table near the ground, a second to determine a similar variation along the showing edge of the roof slab and a third to determine the variation between points on both water table and roof established originally in plumb one with the other. The location of the three sets is shown in the accompanying diagram.

The water-table measurements were made between round-headed brass screws, set in lead expansion shields

*From information furnished by the Aberthaw Construction Co., Boston, Mass.

MEASUREMENTS ON GRAY & DAVIS BUILDING

Location	Date	Separate readings, ft.	Average length, ft.	Average temperature	Movement ft.
Roof (F_1-F_5)	Nov. 7, '13	382.558			
		382.560			
		382.559			
			382.559	69.8°	
	Feb. 12, '14	382.555			
		382.553			
		382.544			
			382.552	17.4	
					—0.007
Base (R_1-R_5)	Nov. 7, '13	379.432			
		379.438			
		379.442			
			379.437	56.9°	
	Feb. 12, '12	379.380			
		379.381			
		379.370			
			379.377	6.2	
					—0.060

Movements of plumb-line points.
First reading Dec. 2, '13. Temp. 44° F. All five points plumb.
Second reading Feb. 12, '14. Temp. 6.2°. Movements of top point as follows

U_1 moved east 0.020 ft.
U_2 moved west 0.010 ft.
U_3 moved west 0.024 ft.
U_4 moved west 0.015 ft.
U_5 moved west 0.026 ft.

(at F_1 and F_5 on the diagram) and approximately 382.6 ft. apart. Intermediate points were established by stakes driven in the ground (at F_2, F_3 and F_4) approximately 100 ft. c. to c. These points were at the same level and in line with the plugs. The difference between the two end points was measured three times, and the temperature taken by three thermometers, at the head, rear and middle of each length. The average temperature for each length was taken in computing for expansion and contraction of the steel tape. The coefficient of steel used was 0.0000063.

A hundred-foot steel tape standardized by the United States Bureau of Standards was used in taking all the measurements. It was standard at 62° F., with a 10-lb. pull when supported its entire length. When unsupported, it required an 18.5-lb. pull at 62° F. to make it standard. This being supplied, the only correction required was that for temperature.

The measurements on the upper part of the building were made on the inside of the parapet wall and from the roof. The points to be measured were established in the concrete corner column (at R_1 and R_5), which extend up above the roof, and were located about three feet from the roof level. They were set in the same way as those in the base. Intermediate points were established at the quarter points (R_2, R_3, R_4). Three separate measurements were made for each length, as for the water-table length. The five plumb lines were established on the south side of this building, in the following manner:

Five brass screws were set in lead expansion shields securely fastened into the concrete work (at U_1 to U_5 on the diagram). These upper points were established in the concrete work over the windows of the upper floor, this concrete being the edge of the roof slab itself. They were established by a man who was hoisted to the desired location in a bos'n's chair. A line was established parallel to the length of the building and about 110 ft. from it. Points were then established on this line to correspond to the five points established on the building, and exactly opposite these, the points established on the top of the building having been approximately plumbed down to a point on the water table below. By double reversal of the transit set up on the base line opposite the different points, points on the water table were established at L_1 to L_5 directly below U_1 to U_5.

The original length measurements were made on Nov.

7, 1913, a bright, sunny morning when the temperature near the ground was 70° F. and that on the roof, which was in the shade, about 57° F. The plumb lines were set on Dec. 2, 1913, the weather being cloudy and the temperature about 44°. On Feb. 12, 1914, a cold, winter day, the measurements were all repeated. The accompanying table gives the results, all measurements being corrected to the same standard.

It is intended to repeat the measurements at intervals in the future.

Water-Supply Projects in Cleveland, Ohio

The City of Cleveland, Ohio, has just started the construction of an extensive addition to its water-supply system, consisting of a new and enlarged water tunnel leading into Lake Erie and a mechanical filter system of unprecedented size.

The first water-supply tunnel for Cleveland was driven in the west side of the city to a crib about a mile and a half out from the shore, known as the west crib. This tunnel was 5 ft. in diameter and was later paralleled by a separate tunnel 7 ft. in diameter reaching the same crib. The original crib and the two tunnels connecting with it were abandoned in 1903 when the east side tunnel from the Kirkland pumping station was completed. This tunnel is five miles long and 9 ft. in diameter, and reaches on a diagonal line to the east crib which is about four miles from shore.

The new tunnel, the preliminary work on which has been commenced, is to start from the earliest or west crib and extend 16,000 ft. farther out into the lake. It is being built by direct labor under the supervision of the Water Department. This new tunnel is to be circular and 10 ft. in diameter. From the west crib to the shore the old 5-ft. tunnel, which has not been in use for a number of years and which is filled with débris, is to be enlarged to 9 ft., so that it, together with the 7-ft. tunnel already in existence, will carry the water from the new 10-ft. tunnel to the shore.

The new 10-ft. lakeward extension tunnel is to be lined with a special type of concrete block cast in a yard and placed on the job. A concrete-block system has been designed by the city's engineers and is now under investigation and test, but no definite statement is now available as to the design. The tunnel will be driven under air. It is proposed to use the old 7-ft. tunnel leading from the shore to the west crib as a construction passageway through which the men and material may be transported to the crib, from which construction of the new tunnel will be continued lakeward. This will permit of work on the new tunnel during the winter and during bad weather, which will materially increase the working time and shorten the period of operations required.

On account of the pollution of the lake water by sewage and also on account of its frequent objectionable turbidity, it has been decided to construct filter plants to purify the water-supply of Cleveland. These plants will be two in number. One will be located on the West Side at the shore end of the new west tunnel and will have a capacity of 150,000,000 gal. per day; the other will be built on the East Side near the shore end of the present 9-ft. tunnel, and will have a capacity of 75,000,000 gal. per day.

In May, 1913, after the Mayor and city officials had decided that city filtration was necessary, the Mayor appointed a Filtration Commission comprised of Prof. A. W. Smith, Case School of Applied Science, President; R. Winthrop Pratt, consulting engineer, Secretary; Dr. Wm. T. Miller, member State Board of Health, Prof. Hippolyte Gruener, Western Reserve University, and Dr R. G. Perkins, city bacteriologist.

This commission submitted a report in July, recommending the installation of a filtration plant of the mechanical type. The commission also established a test plant having a capacity of 100,000 gal. per day, and this has been in operation up to the present time. At the test plant the water is treated with lime and sulphate of iron, an excess of lime being used to soften the water. The results of treating the water in this way have been very satisfactory both from bacterial as well as from chemical and physical standpoints. The operation of this test plant has afforded data which have been of value in the design of the large plant. It has been further demonstrated that Cleveland water is an easy one to treat, so that with the filtration plant of the type proposed, Cleveland should have, without exception, the best and safest supply of any city in the United States.

Owing to the need and popular demand for filtration, the work on the West Side plant will be rushed. Excavation has already been started by direct labor. The city has purchased a steam shovel and this is being operated night and day, the material being loaded upon hopper dump cars belonging to the Cleveland Railway Co., and hauled through the city streets to the easterly portion of the city where it is being used in making a fifill. Excavation and transportation in this way is costing less than 40c. per cu.yd., and the city is getting some necessary filling material as well as making the excavation for the filtration plant.

The remainder of the filtration work will be divided into five different contracts as follows; Contract 1, mixing chambers, coagulation basins, filter foundation, filter units, and main piping; Contract 2, chemical house; Contract 3, filter superstructure; Contract 4, filter equipment; Contract 5, filtered-water reservoir.

Plans for Contract 1, which will involve the greatest expenditure, will be ready before Apr. 1, and it is expected that bids will be taken about Apr. 20.

The work has been planned with the idea of completing the entire plant in the fall of 1915. As soon as completed, the West Side plant will be supplied with water from the West Side tunnel if the same is completed; or if the tunnel is not completed, raw water will be pumped from the present Kirtland St. Station to the West Side plant and there purified and distributed to the entire city.

With the completion of the second filtration plant on the East Side, the filtration system of the city will have a capacity of 225,000,000 gal. per day, which will be the largest system of the rapid sand type, in existence.

The Cleveland Water Works is under the Department of Public Utilities, of which C. W. Stage is Director. C. F. Schulz is Commissioner of Water and with his deputy, C. P. Jaeger, is in personal and immediate charge of the tunnel work. R. Winthrop Pratt is Consulting Engineer on the filtration work and F. H. Stephenson is in immediate charge of design, assisted by R. S. Jones.

The Langwies Arch

By H. Schuerch*

SYNOPSIS—Reinforced-concrete arch of 315-ft. span, on a mountain railway in Switzerland. Two ribs, with batter; cellular abutments. Centering supported on reinforced-concrete trestle towers.

The new electric railway from Chur to Arosa, Switzerland, rises about 1200 m. (3650 ft.) in an almost constant gradient of 6%. As far as Langwies it runs along the right slope of the Schanfigg (valley of the Plessur River), but at Langwies it crosses to the left slope by a high bridge, just where the Sapüner Brook joins the Plessur. The Langwies bridge was designed by Ed. Züblin & Co., of Strassburg and Basel, and this company is also building the bridge. The structure is to be completed by next summer, so that the railway can be opened before winter—an important season for Arosa, a winter-sport resort.

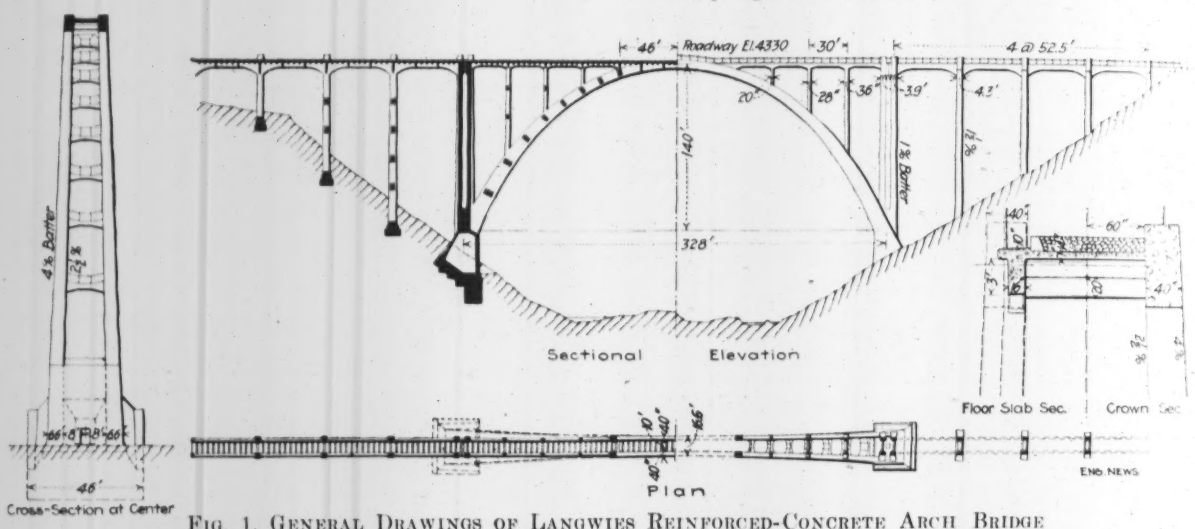


Fig. 1. General Drawings of Langwies Reinforced-Concrete Arch Bridge

The bridge was designed of reinforced concrete, because stone was excluded by high cost and unavailability near the site, while iron was excluded by the transportation conditions, the steep and winding approach road limiting the length of single members to 25 ft. On the other hand, good sand and gravel is found directly at the site, and excellent timber in long lengths is available for centering and staging.

The cross-section of the valley called for a large central arch flanked by approach spans. The conditions were such as to require a very long span, but it was desired not to go far beyond precedent in concrete-arch construction, in point of size.

The Langwies bridge crosses the valley with a middle arch spanning 96 m. (315 ft.) in the clear, or just 100 m. (328 ft.) between centers of skewbacks. The rise c. to c. is 42 m. (138 ft.). On either side there are four approach spans of 48 ft. clear span each. Subsequent to the original design the Langwies approach was changed by adding outside the abutment, to replace a part of the contemplated embankment, the further spans, two of these being 42½ ft. and one 3[illegible]

The central span is a fixed-end arch; the conditions permit a reliable foundation, free from [illegible] risk of yielding. The side spans were better suited [illegible] beam-and-slab crossings. On account of the great height of the roadway above the ground surface, it was desirable to eliminate thrusts, and at the same time the height of the piers makes them flexible enough to take up the expansion of the girders. The location being 1350 ft. above sea level, relatively large temperature fluctuations are to be expected, and therefore expansion is important.

The arch consists of two ribs of depth 82½ in. and width 40 in. at the crown. The width of each rib increases regularly toward the skewbacks, on a batter of 4% outside and 2½% inside. The two ribs are inter-connected by rigid cross-struts.

The unusually high rise of the arch was required by the profile of the crossing, and has the favorable effect of minimizing the temperature and shrinkage stresses. For stability the faces of the arch are battered outward 4%, and the same batter is continued in the side faces of the cellular abutments. The arch gradually merges into a strong base slab, while the open space between the ribs is closed off by a reinforced wall.

Floor—The roadway is 4 m. (13 ft.) wide between railings, the footway on either side occupying 28 in. of this width. The floor slab is covered with 12 in. of broken-stone ballast, deposited on a layer of sand over the cement-surfaced and waterproofed slab. The slab spans betwen the transverse floorbeams. At the columns, the floorbeams are made of increased depth for better sway bracing. Drain pipes are concreted in the slabs every 13 ft. along the center line of the bridge. The cornice has a drip edge.

The floor longitudinals are continuous over five supports; at one end they are connected rigidly with the arch-rib (into which they merge), and at the other end

*Engineer for Ed. Züblin & Co., Strassburg, Germany.

with the large end column. Since the point of connection with the arch-rib must be regarded as immovable horizontally, the intermediate and end columns must be capable of yielding to the longitudinal expansion of the girders. The end column and the highest intermediate column can bend under the girder expansion without suffering injury. The two shorter columns over the main arch are not sufficiently flexible, in spite of being made thinner on account of their reduced buckling lengths. These two columns, therefore, have a joint at the top, and the one nearest the crown of the arch has in addition a joint at the foot.

Approach Spans—The main girders of the side spans are beams of variable moment of inertia. They are continuous over four spans (five supports) and are fixed at one end to the large double column and at the other end to the cellular abutment. The approach abutment is formed of continuations of the girders, and a connecting foundation slab to distribute the load and secure adequate stability.

The intermediate piers are flexible enough to take up the expansion of the roadway. The supporting base is made as narrow as possible, to approximate hinge action. The piers could be made very light by constructing them as two-column bents, as they do not resist the roadway wind-load, this going to the approach abutment and to the main pier over the arch abutment. To take this wind reaction, the main pier is built with an unbroken curtain-wall connecting its two columns, in place of the individual brace-struts. A transverse division plane, however, divides the pier into two independent halves, one half supporting the arch roadway and the other the approach roadway, which thus can expand independently. The two halves of the pier are interlocked laterally by projecting portions which engage each other; this insures equal distribution of wind reaction between the two portions, without interfering with the free expansion of the roadway.

The design of the entire structure was carried out with a view to a maximum economy of materials with minimum stresses. This was facilitated by the fact that the live-load naturally was low in comparison to the dead-load. Instead of employing a full arch-barrel for the large arch, two ribs connected by brace struts were employed. The railway being of narrow gage (meter gage), a very narrow ring would have sufficed, except for the two important factors of (1) wind resistance, and (2) strength against buckling of the entire arch as a compression member.

Loads and Stresses

The loadings employed in the design of the bridge were as follows:

WEIGHTS OF MATERIAL FOR DESIGN OF LANGWIES ARCH

Material	Metric tons per cu.m.	Lb. per cu.ft.
Reinforced concrete	2.5	157
Plain concrete	2.3	144
Ballast	1.8	112
Back-fill	1.8	112

(a) *Dead-load*, according to the unit-weights tabulated below.

(b) *Live-load*. The rolling-stock on the Chur-Arosa railway will consist of 44-ton motor cars and 33-ton trailers. However, the Swiss Railway Department required the bridge to be designed for loadings applicable to narrow-gage railways using locomotives, as specified in the Federal Railways bridge and roof specifications of June, 1911. Accordingly, the bridge was designed for a train composed of two locomotives weighing 72 tons loaded (engines of the Rhätische Bahn), followed by a continuous line of freight cars. On spans shorter than 15 m. (49 ft.), these live-loads were increased by $(15 - l)$ %, l being the span in meters.

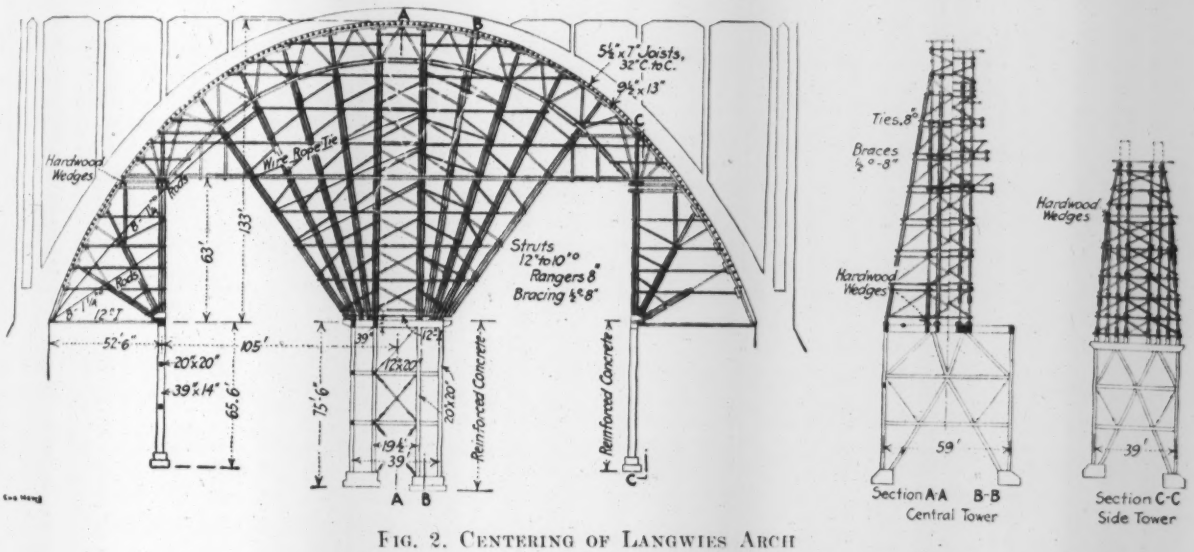


Fig. 2. Centering of Langwies Arch

Secondary loads or influences were specified as follows:

Temperature changes of ± 15° C. (27° F.), and the influence of shrinkage equivalent to a further temperature decrease of 20° C. (36° F.).

Braking load, taken as $^1/_7$ of the wheel-loads.

Wind load, takes as 100 kg. per sq.m. for loaded bridge and 150 kg. per sq.m. for unloaded bridge (20½ and 31 lb. per sq.ft.). The surfaces exposed to wind were taken as being: the front face of girders, twice the front face of columns, one and one-half times the front face of the double pier, and for trains a rectangular surface 3 m.

(10 ft.) high with center of pressure 2 m. (6½ ft. above rail.

Stresses—The following maximum allowable stresses were prescribed:

Stress	Kg. per sq.cm.	Lb. per sq.in.
Concrete:		
Dead- and live-load	35	500
Dead, live, shrinkage, and temperature (— 35° C. or + 15° C.)	45	640
Shear	4	57
Steel:		
Dead- and live-load	1000	14,200
All stresses	1200	17,100

It was required that the concrete be subjected to daily sampling and test, and that it show a 28-day strength of at least 2500 lb. per sq.in. for wet-mixed concrete, or 3500 lb. per sq.in. for dry-mixed concrete.

The modulus of elasticity of concrete was taken as 2,000,000 t/m^2 (2,800,000 lb. per sq.in.).

The ratio Es/Ec was taken as 15.

In those parts of the structure where the stresses are mainly compressive, as in the arch and the columns, the stresses were calculated according to Ritter's method. The same method was used for computing the tension in concrete in bending (the Swiss provisions require the tension to be computed). In all other members, i.e., those mainly carrying bending, the concrete compression and steel tension, were computed according to Christophe's method. Shear stresses were computed with particular care, and provision was made that wherever they exceed 4 kg. per sq.cm. all the shear is absorbed by reinforcement (stirrups); this means that stirrups were used liberally. Computation of buckling resistance was made by Ritter's method.

Centering

Special mention should be given to the interesting and remarkable centering of the arch. It consists in its upper part of fan-shaped timber construction (for which round timber was used almost exclusively, this being obtainable in good quality, long lengths, and at low price, close by the site), supported by three reinforced-concrete towers, designed as braced or trussed frames. The use of such towers was decided upon for the following reasons: (1) The exposure to freshets during the spring thaw, when the two brooks which join at the bridge site often carry enormous masses of water and rock drift, made it important that the valley should be but little obstructed by the centering. Therefore a system of vertical center framing was excluded, and the tower system was necessarily adopted. Wooden towers, however, would have obstructed the valley more than the reinforced-concrete towers, and at the same time would have been less secure. Second, the total compression of the centering under the weight of the concrete should be a minimum, which requirement also argued for use of reinforced-concrete towers.

Automatic River Gage Mistaken for Infernal Machine—The U. S. Geological Survey quotes a press dispatch and comments on it as follows in one of its press bulletins:

Sanger, Calif., Feb. 3—An intricate infernal machine which, if loaded with nitroglycerin and discharged, could have done inestimable damage, was found in the flotsam deposited near this city by the recent flood. The machine consists of a clock-like arrangement attached to a brass cylinder. It is inclosed in a glass case. This instrument of destruction is now in the hands of Constable Campbell, and will be turned over to Government officials.—Fresno "Herald."

This dangerous instrument is a Friez automatic river gage which has been faithfully recording the ups and downs of Kings River for nearly 11 years for the United States Geological Survey. The recent flood exceeded by 6 ft. the maximum recorded stage for the past 18 years and swept the gage away from its mooring.

Poured Sewer-Pipe Joints

By A. Elliott Kimberly*

Efforts to introduce poured joints for the construction of sanitary sewers, that is, the use of G-K, oakum or other similar materials, while meeting with [illegible] success in the Middle West, appear to be proceeding slowly. In the writer's experience, this is due to: (1) Lack of experience in the use of the compounds; (2) uncertainty of successful application; (3) lack of definite information regarding actual practical cost.

In the case of three undertakings with which the writer has been connected, there have been received alternate bids for poured joints and for cement joints. The accompanying table, made up on a practical bidding basis, affords a strict comparison between these two types of joints. It is interesting to note that the bids for poured joints for the three systems average, respectively, 29, 34 and 21% higher than for cement joints.

It is readily appreciated that municipal officials at times hesitate to authorize the additional expenditure necessary for poured joints, even though the engineer details at length the well known advantages that accrue from tight sewers, especially when pumping is necessary or when treatment of the sewage is required. In the three cases cited in the table, the contracts were awarded upon the basis of using compound when the presence of water in the trenches would, in the judgment of the engineer, justify the use of jointing material, but in none of these cases were poured joints used.

ALTERNATE BIDS ON SEWER PIPE LAID WITH CEMENT AND WITH POURED JOINTS*

Size of pipe, in.	Lin.ft.	Price per lin.ft. Cement joints Max.	Min.	Av.	Poured joints Max.	Min.	Av.	Av. % increase
Urbana, Ohio, Sept., 1912; 12 bids								
6		0.40	0.15	0.215	0.50	0.165	0.290	34.9
8	53,441	0.50	0.20	0.252	0.60	0.23	0.334	32.5
10	4,896	0.65	0.27	0.336	0.75	0.292	0.441	31.3
12	4,502	1.00	0.33	0.437	1.10	0.376	0.568	30.0
15	1,372	1.45	0.48	0.626	1.55	0.538	0.788	25.9
18	3,153	†0.97	0.65	0.778	†1.29	0.74	0.975	25.3
20	5,785	1.34	0.80	0.963	1.55	0.94	1.181	22.7
Bexley, Ohio, May, 1913; 6 bids								
8	28,529	0.30	0.15	0.247	0.45	0.19	0.349	41.3
10	4,824	0.405	0.21	0.336	0.52	0.28	0.451	34.3
12	4,313	0.5075	0.33	0.428	0.65	0.34	0.543	26.9
Wapakoneta, Ohio, Nov., 1913; 4 bids								
15	1,530	0.65	0.55	0.60	1.00	0.58	0.733	22.1
20	1,004	1.20	0.88	1.033	1.50	0.95	1.24	20.0

* All pipe deep and wide socket and 3-ft. lengths; prices for laying pipe only. The Urbana Contract was awarded for $78,663; the Bexley, for $41,725; the Wapakoneta, for $10,424. † Unbalanced bid.

It has not been the writer's fortune to secure at first hand cost data from work of any magnitude, but from conversation with engineers and contractors who have used G-K jointing material, he has learned that the cost considerably exceeds that indicated by the company's published tables. This fact appears intimately related to: (1) method of preparing the compound for pouring; (2) quantity of hemp used in making joints; and possibly (3) variation of annular space.

Comments on Preparation of G-K for Pouring

The successful economical use of the G-K jointing compound for vitrified sewer pipe is dependent to a large extent, in the writer's experience, upon the method of heating, especially the preparation of the material for the melting pot, the kind of kettle used, the means for applying and maintaining the heat and the temperature to which the melted compound is raised and maintained.

*Hydraulic and Sanitary Engineer, 8 East Long St., Columbus, Ohio.

There appears to be but little published practical information respecting precautions necessary in melting the compound and with regard to the chemistry of the heating and melting process. Suggestions which if followed out may serve in part to prevent failures, unsatisfactory results and waste of compound are as follows:

(1) Break up the material into comparatively small pieces before heating.

(2) Use if possible a kettle arranged to prevent the bare flame from coming into direct contact with the bottom of the kettle.

(3) Do not attempt to draw off material from kettle through a pipe unless the valve is jacketed (that is, is inside kettle), especially during cold weather; otherwise solidification will take place with stoppage of pipe.

(4) Use a covered kettle to minimize volatilization.

(5) Do not attempt to use material, even for vertically poured joints, until ebullition period has ceased.

(6) Prepare only sufficient melted compound for the joints calked and ready for pouring, in view of the liability of carbonization or change in chemical composition, in a comparatively short time after the ebullition period is over. Certain experiences have indicated that carbonization may be overcome, in large part, at least, if fresh material is added to the melting pot as soon as jointing is temporarily complete. It is particularly to be noted that the introduction of fresh compound will necessitate again passing through the ebullition stage, so that temporarily, jointing must cease entirely.

(7) Do not attempt again to use material that remains in the kettle after the day's work is over, in order to guard against the use of carbonized, overheated or chemically changed material.

Calking

Published tables of quantities of G-K required for different sizes of pipe, deep and wide socket and standard, are stated to be calculated upon the basis of a definite depth of hemp, a definite annular space and the stated depth of compound, together with an allowance of 5% for waste and 5% for variation in the dimensions of the pipe. A moment's thought will suggest that the relatively sparing use of hemp and the generally crude calking of hemp in cement joint making leaves a space for jointing material much in excess of that on which is based the tabulated quantities of jointing compound. It is also important that when calking is completed the hemp shall be a uniform distance from the top of the bell. Special attention must, therefore, be paid to the quantity of hemp used and to the calking. Hemp is cheaper than compound. These considerations in particular may help to explain the greater use of compound than that stated in published tables for G-K.

Deep and Wide Socket Pipe Preferable

Much advantage appears inherent in the use of deep and wide socket pipe in 3-ft. lengths, especially as regards ultimate water-tightness, rapidity of laying and particularly the formation of complete poured joints. The writer's experience has shown that melted compound will not at all times flow completely around the 3/8-in. annular space of the smaller sizes of standard vitrified sewer pipe, owing to rapid solidification, which results in forming a joint incomplete at the important invert point. The joints in question were made when the air temperature was 70° F.

Variation in Annular Space

In some cases, especially if the sewer pipe used is not of first quality, there may be sufficient variation in annular space to account for a greater use of jointing material than required by the tables. As to how important this proposition is with reference to standard pipe, well burned, true and straight, the writer has little or no information. This point appears worthy of investigation in view of possible large variations in annular space due to excessive thickness of spigot ends, or to enlargement of bells.

Suggested Studies

To assist engineers, contractors and others in using poured joints for sewers the writer suggests a need for thorough study and research, especially to investigate:

(1) The chemical changes which the compound undergoes upon prolonged heating.

(2) The question of volatilization losses at different temperatures.

(3) The proper temperature limits to secure correct results.

(4) The relation between the composition of the oil, sulphur and the clay to the chemical changes incident to continuous heating subsequent to the ebullition period.

(5) The optimum method of heating and the development of: (a) A portable furnace or melting pot; (b) tests for water-tightness, supplementary to those prepared under the auspices of the manufacturers.

For the benefit of those not already informed, it may be stated that the G-K compound for making poured joints, appears to be a mixture of clay, sulphur and linseed oil. The mixture, it is understood, is heated to a temperature sufficient to effect a vulcanization of the oil and the formation of a homogeneous mass. The compound is manufactured by the Union Clay Products Co., New Brunswick, N. J.

⁂

For Fraudulently Securing A Miner's Certificate John Dupski, of Brady, Penn., was recently fined and imprisoned by Judge Moser, at Sunbury, Penn., as was also Martin Grobofsky, of Brady, who obtained the certificate from the Board at Shamokin, Penn., and sold it to Dupski for $2.50. In sentencing them Judge Moser said:

I have several requests for leniency in your behalf on account of your families, which I have considered. We must also consider the seriousness of your crime. It is you, and men like you, who flood the mines with incompetents and endanger the lives of fellow workers whose occupation is hazardous enough. The Court feels they must support the Board, otherwise their work becomes useless and the intent of the law is defeated. The sentence of the Court is that you each pay a fine of $25, the costs of the suit and serve one year in the Sunbury jail."

The Submarine Coal Fields of Cape Breton, situated on the northeast coast of the Island of Cape Breton, Nova Scotia, were interestingly described by C. M. Odell, in a paper read at the Jan. 8 meeting of the Mining Section of the Canadian Society of Civil Engineers. These coal fields, destined to become one of the largest coal-producing centers in North America, are divided into four basins known locally as the Morien, Glace Bay, Lingan and Sydney Mines.

At the present time the Dominion Coal Co. controls by lease from the Nova Scotian Government most of the coal areas on the southern side of Sydney harbor. A royalty of 12½ cents per ton is paid on all coal marketed, and this forms the greater part of the revenue of the Province of Nova Scotia. The coal is shipped mainly to Sydney and Lewisburg harbors, where modern shipping piers have been erected.

In the near future eight collieries will be opened on the Lingan basin. Four of these are now practically complete and producing their estimated full capacity of 1200 tons per day. These new collieries will exhaust the operations on the Victoria and Lirgan basins, leaving future enlargement of production to two other seams. When the latter are opened five more mines will have been added to the operations on the Lingan basin, making thirteen mines in all in an area of 10 sq.mi.

The Application of Electric Motors to Shovels*

By H. W. Rogers†

The first steam shovels used in this country were built by the Otis Co., of Boston, about 50 years ago, but they were of very crude construction and not very successful.

For possibly 10 years prior to 1884 successful steam shovels were made and used on certain classes of work, but it was not until then that they were manufactured in quantities and began to play an important part in all classes of excavation. From that time up to the present day there have been gradual but continuous improvements on the original shovel, not only in the mechanical construction, but also in the design of boilers and engines best adapted to this class of service.

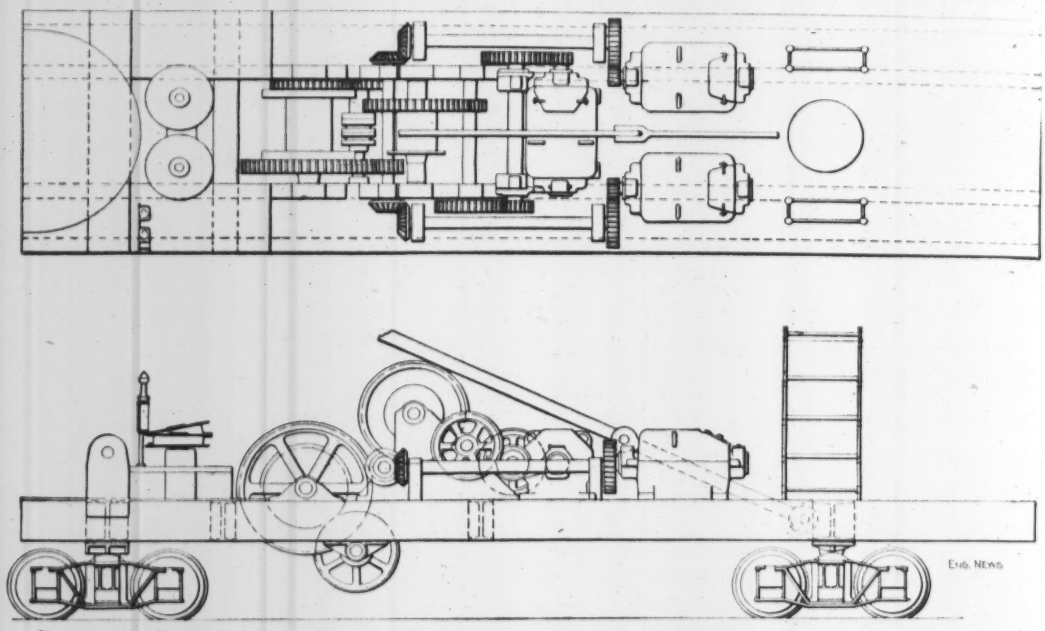
In proposing a change from steam to electric operation we have to deal with a steam equipment which has not only proved its worth, but has probably reached its highest stage of development and efficiency. That the electric shovel is a possibility cannot be denied, as at present from 12 to 18 shovels are in operation in this country. These shovels may be divided into three classes; the friction-electric, which is operated by a single constant-speed motor with friction clutches; the three- or four-motor direct-current equipment, and the three- or four-motor alternating-current equipment. It is the second and third classes that I wish to discuss, as the friction-electric does not compare favorably with the steam shovel so far as speed is concerned, although it may be operated as cheaply.

There is probably no other class of machinery that presents a duty cycle as severe as that of the shovel. It is very short, varying from 7 to 12 sec. on the hoist, 7 to 12 sec. on the thrust, and 10 to 18 sec. on the swing, making a complete cycle in from 17 to 30 sec. The motor to meet these requirements must have a sufficiently low armature inertia to permit of rapid acceleration and quick reversals under small power. It should also be a motor of rugged design, as it must be subjected to severe overloads and shocks and frequent reversals. This is especially true of the hoist motors and, to a lesser degree, of the swing motor; the thrust motor is practically stalled during the digging operation, although it may revolve or overhaul, according to conditions, and is operated at full speed only after the hoisting operation is completed.

In the case of the hoist, considerable advantage may be gained by using two motors of small capacity instead of one large motor, as the power required for accelerating is much less. For example, assume a shovel that requi[illegible]-hp 425 r.p.m. motor for the hoisting operation; t[illegible] quires 117-hp. torque to bring it to speed in 1 [illegible] if we substitute two 75-hp., 500 r.p.m. motors [illegible] each motor requiring 32.3-hp. torque to bring it [illegible] 1 sec., or 64.6-hp. torque to bring both motors t[illegible] sec., there would be a saving of 45% in the po[illegible] to accelerate the motors alone. A plan showi[illegible] method of locating and gearing motors to hoist [illegible] machinery is given in the cut.

Although there may be some demand for eq[illegible] operate on direct-current circuits, the greater [illegible] required to operate on 60-cycle alternating-curre[illegible] The direct-current series motor has the characteri[illegible] steam engine, in that it gives its heaviest torque [illegible] speeds up under light loads and slows down [illegible] loads. It is much easier to control and requires [illegible] less apparatus, insofar as the control is concerned, than the alternating-current equipment.

The saving in operating expense of the electric shovel over the steam shovel will depend somewhat upon the comparative cost of coal and electric power and will vary for different localities; but it should be remembered that the electrically



Plan and Elevation of Shovel, Showing Best Arrangement of Motors and Gearing

operated shovel eliminates the fireman, watchman, coal passer, teaming for ½ day, the use of water, and considerable waste. The natural increased wear and tear of parts having a transverse motion as compared with those having rotary motion and the elimination of boiler trouble should also be considered.

Labor per shift	Steam	Electric
Shovel runner	$6.00	$6.00
Craneman	4.00	4.00
Fireman	2.50	.....
Six pitmen at $1.75	10.50	10.50
One watchman	1.75	.....
One coal passer	1.50	.....
Teaming (½ day)	2.50	.....
Oil and waste	1.50	0.75
Total	$30.25	$21.25

For convenience in comparing the costs of operation on steam and electric shovels the costs are all reduced to a day basis.

	Steam	Electric: Direct Current	Electric: Equivalent Alternating Current
Interest at 6%	$5.20	$7.75	$10.85
Depreciation at 4⅓%	4.03	6.00	8.43
Repairs at 10%	8.66	.....	.....
Repairs at 6%	.....	7.75	10.85
Labor per shift	30.25	21.25	21.25
Total cost per shift	$48.14	$42.75	$51.38

It has been assumed that, owing to weather conditions, delays, etc., the shovel working year consists of 150 days and the above figures are based on this assumption; also that the shovel is only working one shift a day.

*Abstract of paper presented at the annual meeting of the American Institute of Mining Engineers, at New York City, on Feb. 17.

†General Electric Co., Schenectady, N. Y

In selecting a shovel equipment it should be remembered that although it is possible to operate with alternating current it is cheaper to use the direct-current equipment, even with a motor-generator set, and have an outfit which more nearly approaches the characteristics of the steam shovel, and has much simpler control apparatus and requires considerably less power to operate it than the alternating equipment with transformers. In addition to this, any change in the frequency would mean a complete change in the equipment of an alternating-current shovel while it would mean only a change in the induction motor of the motor-generator set, with possibly a change in the generator fields, on a direct-current equipment.

Small Sewage-Pumping Plants*

By S. A. Greeley and Langdon Pearse†

The design and operation of small sewage-pumping stations is a subject upon which very little has been written. One reason, perhaps, is that the use of such stations is avoided as far as possible in the design of sewerage systems for the smaller towns and villages, even at the risk of flattening grades to a point where thorough scouring may not always occur at low flows. However, on small areas and frequently on larger areas where conditions are imperative, pumping stations are built to lift the sewage into the outfall sewers or to works for treatment.

In the design of the small stations, there are several points to be considered. (1) Preparatory treatment by screens is required to protect the pumps. This is more important on small installations, particularly those where attendance is intermittent. Bar screens with net openings of ½ to ¾ in. are common. There should be ample provision for ready cleaning and accessibility. (2) There should be provision of storage in a suitable well or tank, in order that pumps of reasonable size may be used with intermittent pumping. Sometimes pumping installations may serve to dose treatment works. The design should provide bottom slopes steep enough to keep the sludge moving to the pumps. (3) There is the question of location and character of buildings. (4) The total cost for operating and maintenance capitalized and added to the construction cost will give a means for comparing the relative merits of different sources of power available.

For the small sewage-pumping station, where intermittent attendance is planned, the use of electrically driven pumps would seem to be ideal. They are clean, self-contained, noiseless, and easily controlled by well developed devices for automatic starting and stopping. Attendance is thereby reduced to a minimum. The equipment is usually compact and may be installed in comparatively small space. The cost of pumping depends on the local energy rates and is clouded only by the necessity of pumping intermittently rather than continuously. This increases the peak load on pumps.

Electrically driven direct-connected pumps operate efficiently and economically. The recognized features would seem to be (1) vertical motors with a suitable oil bearing to support the moving parts of the motor; (2) support of the moving shaft and runner of the pump on a ball or roller bearing (placed above high water), and (3) connection with the motor by a flexible coupling. Steady bearings are desirable on the shaft at frequent intervals, with provision for oiling and accessibility. It is highly desirable, with any type of sewage-pump installation that it be set in a dry well (so far as possible) so that none of the moving parts requiring lubrication will be exposed to the sewage. This may frequently contain grit, which is destructive to bearings. The necessity of keeping gritty water out of water seals and bearings has not been always recognized by designers, as operating men have found.

Gas engines have also been developed for this service, operating on natural gas or artificial gas from mains. But with a very few exceptions (notably a small pumping station in Newton, Mass., handling sewage of about 760 people, with two 3½-in. centrifugal pumps), the developments have been mostly in the larger stations, such as the East Side plant at Columbus, Ohio, where two 60-hp. gas engines operate two 10-in. centrifugal pumps, chain-belt driven. At Hegewisch, in Chicago, the pumps are run by gas engines fed from the city mains. The latter installation is belt-driven and pumps the entire sewage, as well as a large proportion of the storm flow. The Columbus station handles only the dry-weather flow and a very small proportion of the storm sewage. The Newton station is semiautomatic, being started two or three times a day by a fireman from the neighboring

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors.

†Division Engineers, Sanitary District of Chicago, Chicago, Ill.

TABLE OF COST DATA AND STATISTICS OF SEWAGE PUMPING

Station	Type	Approximate water hp. capacity	Approximate water hp. output	Cost of construction per w.hp. capacity	Cost of operation per w.hp. output per year: Labor	Fuel	Repairs, supplies, etc.	Total	Date of data
1. Pennypack Creek, Phila.	Producer gas	45.0	9.0	$450	$735				1913
2. Hegewisch, Chicago	City gas	30.5	21.0	465	1890	$210	$323	$2423	1912
3. Alewife Brook, Boston	Steam	50.0	7.7		828	210	95	1133	1912
4. Quincy, Mass.	Steam	70.0	15.2		417	110	48	575	1912
5. Saratoga, N. Y.	Electric	31.8	....	170	....	....	....	....	1907
6. Hudson, Mass.	Electric	8.0	....	450	....	....	....	....	1907
7. Newton, Mass.	Electric	2.5	0.14	840	775	1020	1105	2900	1906
8. Plainfield, N. J.									
Monroe Ave.	Air	....	0.25	....	....	760	....	....	1912
Randolph Rd.	Air	4.5	1.00	1040	....	586	....	....	1912

Note:—A water horsepower is figured from the rated capacity or actual output of water per day and the total lift.

(1). Pennypack Creek Sewage Disposal Works, Philadelphia, Penn. Present average quantity pumped, 1,000,000 gal. per 24 hr., against 50-ft. head. The equipment consists of one 2,000,000-gal. and one 3,000,000-gal. vertical submerged centrifugal pump, geared to gas engines; and one 150-hp. gas producer operated with anthracite coal.

(2). Hegewisch Sewage Pumping Station, Chicago, Ill.—Built in 1909. Present average quantity pumped, 1,500,000 gal. per 24 hr., against 10-ft. head. Two 10,000,000-gal. centrifugal pumps, and two 40-hp. gas engines using city illuminating gas.

(3). Alewife Brook Pumping Station, Metropolitan Sewerage Works, Boston, Mass. Present average quantity pumped, 3,500,000 gal. per 24 hr., against 13-ft. lift. Two 4,500,000-gal. vertical centrifugal pumps, and one 13,000,000-gal. horizontal centrifugal pump; all operated by compound steam engines.

(4). Quincy Sewage Pumping Station, Metropolitan Sewerage Works, Boston, Mass. Present average quantity pumped, 4,000,000 gal. per 24 hr. against 22-ft. lift. Three centrifugal pumps of 3,000,000, 5,000,000 and 10,000,000 gal. capacity, operated by compound condensing engines.

(5). Saratoga Springs, N. Y. Daily pumpage varies from 1,500,000 to 3,000,000 gal. per 24-hr. against 30-ft. lift. Three vertical submerged centrifugal pumps with capacities of 1500 gal. per min. each, and three 20-hp. induction motors.

(6). Hudson, Mass. Two vertical centrifugal pumps, each with a capacity of 500 gal. per min. against a total head of 35 ft. Each pump is operated by a 15-hp. induction motor.

(7). Newton, Mass. The average daily quantity pumped in 1906 was 25,565 gal. against 30-ft. lift. Two 3½-in. vertical submerged centrifugal pumps geared to 5-hp. vertical gasoline engines.

(8). Plainfield, N. J. Randolph Road Pumping Station. Present average quantity pumped, 130,000 gal. per 24 hr. against 40-ft. lift. Two 10x6-in. compressors; two 7.5-hp. electric motors, one gasoline engine for reserve, one 3½x8 ft. air receiver, and two duplex displacement ejectors. The plant capacity is approximately 500 gal. per min.

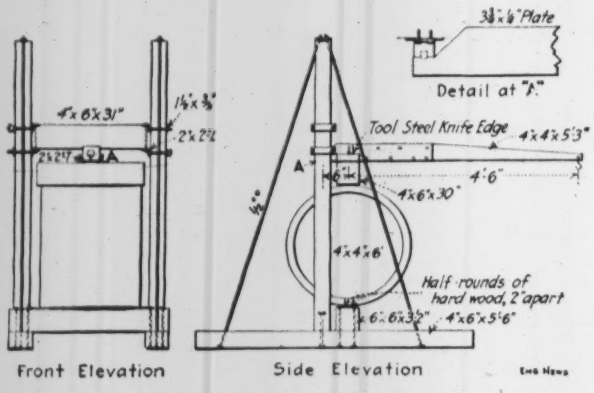
Monroe Ave. Pumping Station. Present average quantity pumped, approximately 30,000 gal. per 24 hr. against 40-ft. lift. Two air compressors, two 5-hp. electric motors, and two 150-gal. ejectors. The plant capacity is approximately 300 gal. per min.

water-works pumping station. A stopping device is installed.

The use of producer gas for the purpose of sewage pumping, as well as water-works pumping, appears attractive, but has not been used to any great extent for small installations, since the attention of the promoters of producer gas has been directed largely to industrial installations, and the municipal field has been left untouched. There is, however, a station operating at Pennypack Creek in Philadelphia.

Gasoline and kerosene for sewage pumping are, of course, available, but with the present price of gasoline, the cost is high. Kerosene is less expensive, but seldom used. However, engines working on distillate, common in California, should prove as successful for sewage pumping as they have for irrigation. Madison (Wis.) pumps all the dry-weather flow with engines converted to run on kerosene.

Sewage installations, however, require to be operated intermittently, as a rule, and therefore need automatic



MACHINE FOR TESTING THE STRENGTH OF DRAIN TILE

control where attendants are lacking. This favors the direct-connected, compact, electrical units. The gas engine and other types of explosion engine require somewhat more attention and care in order to secure successful operation. For the sewage-pumping station in the small town, steam-driven machinery is generally out of the question, as the efficiency here is low and the cost of attendance high. It is only when the installations are operated in connection with other works that steam appears to be attractive for small stations, working on low lifts and handling amounts of sewage under 1,000,000 gal. per day.

Some interesting data on the cost of small plants are given in the accompanying table, p. 613, showing the cost calculated to water horse-power, regardless of the efficiency produced. We have also tabulated the costs of operation as taken from the various records in print. These costs of operation are given with the reservation that if used they should be carefully studied from the standpoint of actual application to a case in hand, as there is a tendency in many municipal records as given out to make as good a showing as possible by giving only the charges apparently chargeable to the pumping account and carrying other incidentals where necessary in other ways. Notes giving various particulars of the sewage pumping plants listed in the table are appended to the table, at the foot of page 613.

Machine for Testing Drain Tile*

BY DUFF A. ABRAMS†

The testing machine described below was designed by the writer for use in the Laboratory of Applied Mechanics of the University of Illinois. It consists essentially of a simple framework and a lever for applying the load by means of dead weight. The load is applied throughout the length of the tile along the top and bottom. After the test, the weight on the lever is determined. To obtain the breaking load on the tile, this weight is multiplied by ten and a constant quantity is added, due to the weight of the loading lever (about 100 lb. in this machine). The machine measures 31 in. between uprights and will take tile up to 42 in. inside diameter.

The main members are of timber. Metal knife-edges are provided for the bearing of the loading lever on the top loading block, and for taking the upward thrust against the top cross-block. The knife-edges bearing on the block over the test tile are 5 in. c. to c., and a single knife-edge takes the end thrust. This gives considerable freedom to the top loading block and causes the load to be applied centrally, although the top and bottom elements of the tile may not be parallel. Tiles which are out-of-round in different ways at the two ends may be readily loaded in this machine, and there is little chance for an unequal distribution of load.

The bottom loading block is provided with two small half-rounds of hardwood placed about 2 in. apart, which allow the tile to seat itself in place. The load is applied at the top along a single element. Cushions consisting of short lengths of flattened rubber-lined fire hose are used to distribute the load along the length of the tile, and also serve to minimize the concentration of load due to irregularities of the surface of the tile. The top cross-block can be placed and held in any position along the uprights, to accommodate any diameter of tile up to about 42 in.

For this kind of a test it has seemed the simplest way to fix the two strips on which the tile rests at a definite distance apart. An analysis of rings shows that when the bearings on these strips are 2 in. apart, the resulting bending moment will be but 2½% different from that for a single support for tile 6 in. diameter and 0.25% for a tile 12 in. diameter, while for larger sizes this variation will be much less. Under the conditions of such tests it would seem better to fix the distance for these strips, and use a common expression for the formula for the bending moment for all sizes of tile to be tested.

If desired, the modulus of rupture of the material may be determined from the dimensions of the tile and the bending moment developed by the load. It would seem that 0.16 Qd is a satisfactory expression for the bending moment where Q is the concentrated load applied at the crown and d is the mean diameter of the tile. For the modulus of rupture of the material f, the formula would be

$$f = 0.69\,\frac{Qd}{l\,t^2}$$

where l is the length, and t the average thickness of the tile along the top and bottom elements.

This method of testing was selected in preference to a method involving the bedding of the tile in sand or other material, because of its simplicity and on account of the difficulty in embedding large tile in sand in such a way as to obtain a known distribution of pressure in tests on tile of different sizes. The method of concentrated loads will give a more definite index of the strength of the material.

Our experience with this machine leads us to believe that it furnishes a satisfactory method of determining the quality of drain tile. This machine weighs about 225 lb. It should cost not more than $20 to $25 in a shop equipped for wood and metal working.

Two Million Surprise Tests were made during 1913 by the Pennsylvania R.R. in ascertaining the observance of train-safety rules. The average result was 99.9% strict observance. Out of 56,929 tests of signals, 99.4% showed perfect observance by employees. Of 2705 caution signals, only 8 cases of disregard were found. Some 16,000 tests were made for flag-signal observance by enginemen and only 11 cases of negligence were noted. The 133,000 observations on handling explosives and inflammables showed 152 infractions of rules. Only 18 derelictions were found in 137,175 cases of tests to ascertain whether trains were leaving or arriving ahead of time.

*From a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors, at Peoria, Ill., Jan. 30.

†Associate, Engineering Experiment Station, University of Illinois, Urbana, Ill.

The "Thermos Bottle" Barges of the Lehigh Valley Railroad

Five new barges are being used in New York harbor by the Lehigh Valley R.R. for the transfer of perishable freight under protection from extremes of heat and cold. The fanciful name "thermos-bottle," given to this barge by the railroad, describes the design so far as concerns

FIG. 1. THE "THERMOS-BOTTLE" BARGE

mere prevention of heat transfer inward in summer time or outward in winter. However, the mechanical construction is not that of vacuum walls and reflecting surfaces as will be seen from Fig. 2.

The boat is an ordinary type of harbor barge except for the provisions to maintain a uniform temperature of 40° F. It is scow built and has the following dimensions: Length over all, 90 ft.; beam over all, 30 ft. 8 in.; height of house, 10 ft. 9 in.; depth of hold, 9 ft. At either end of the barge house is an ice box, the ice being taken in through the upper deck and the waste water draining off into the hold. The bottom of each box is lined with galvanized iron turned up 10 in. on the sides and ends.

Each barge is fitted with a stove for winter. This is set on a concrete block 4x5 ft., 4 in. thick. The stove has a guard around it to protect the cargo from fire, and is incased in a sheet-iron frame 4 ft. 6 in. high. Each barge captain lives on his boat, in the cabin above the house, and is charged with keeping constant watch on the temperature.

Each barge is equipped with two ship-windlass capstans, one on either end of the boat. These barges were built for the railroad by the Perth Amboy Dry Dock Co. of Perth Amboy, N. J.

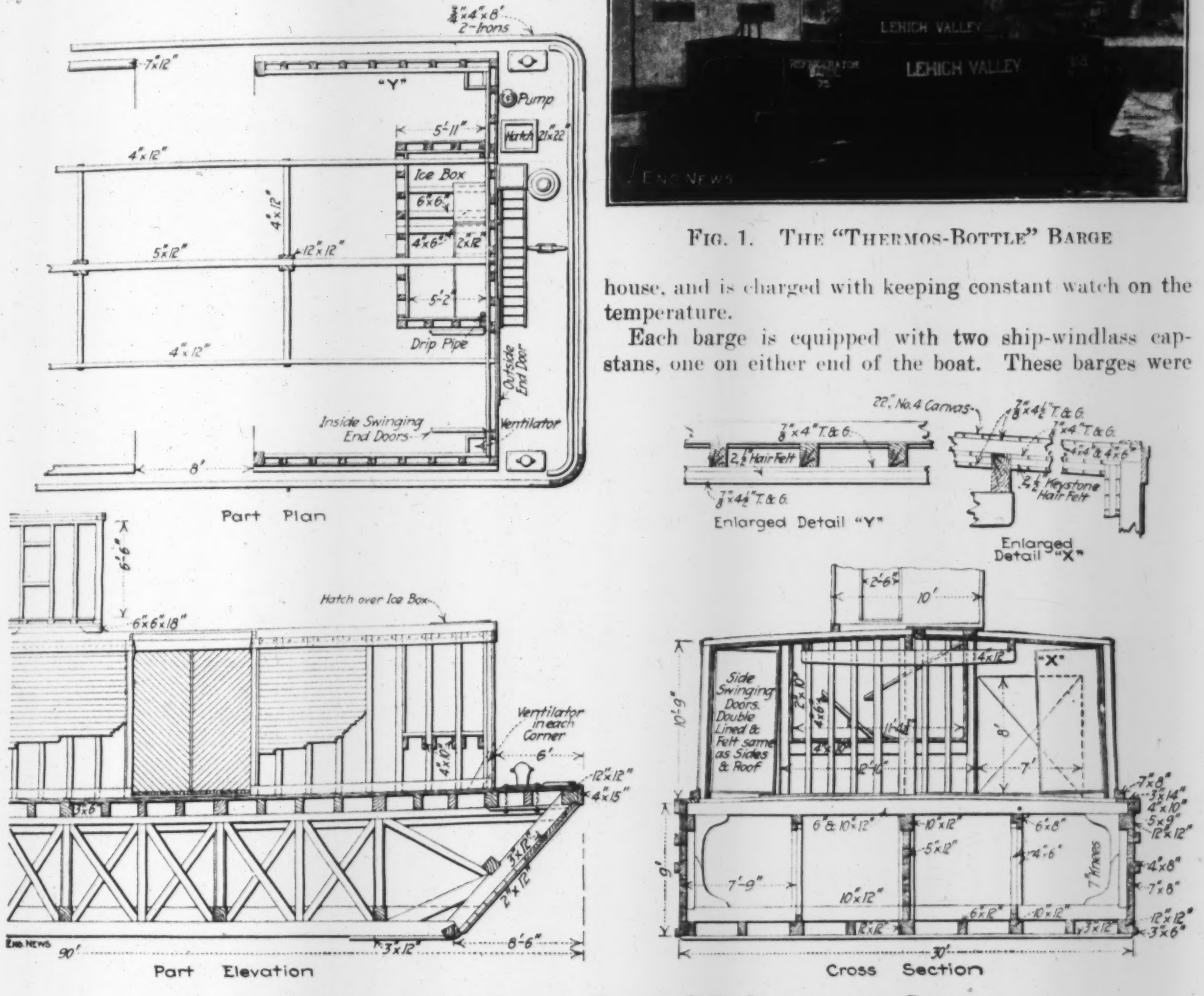


FIG. 2. PART SECTIONS OF LEHIGH VALLEY R.R. REFRIGERATOR BARGES

A Portable Crane-Controlling Device which is in use at the docks of the Manchester Ship Canal Co., at Manchester, England, enables a cargo-handling crane to be controlled by an operator standing near the work instead of riding on the crane. The controller weighs about 7 lb. and is hung from the operator's shoulders; two handles govern the lifting, lowering and swinging movement. From the controller switch an armored cable leads to the crane ring and to a set of small collector rings, the motors being operated through a system of contractors. By means of this appliance the discharge and loading of ship's cargo can be performed more rapidly and safely than under the ordinary system. The crane operator can stand at the ship hatchway, move about freely and keep in sight and control of the load from the time it leaves the bottom of the hold. (From report of the Yards and Terminals Committee, presented at the annual meeting of the American Railway Engineering Association.)

American Railway Engineering Association

(EXTRACTS FROM COMMITTEE REPORTS)

Railway-Tunnel Ventilation*

Tunnels less than ½ mile in length, when constructed according to the adopted section of the Association, and with traffic of less than 30 trains daily, do not usually require artificial ventilation. There are many tunnels in this country of a greater length that carry successfully a greater traffic without the aid of artificial ventilation, and while there is in general a direct relation in the need of ventilation to length and section of tunnel, and amount of traffic, there are exceptions growing out of local atmospheric conditions and local operating conditions that preclude fixing any definite length or size of section as the limit for the installation of artificial ventilation.

The most practicable, effective and economical artificial ventilation for tunnels carrying steam-power traffic is to be obtained by blowing a current of air into one end of the tunnel for the purpose of removing, or diluting and removing, the smoke and combustion gases at the opposite end. As practiced in America, this way of procuring ventilating partakes of two methods:

1. To blow the current of air in the direction the train is moving and with sufficient velocity to remove the smoke and combustion gases ahead of the engine;

2. To blow the current of air against the direction of the train with velocity sufficient to dilute the smoke and combustion gases to such an extent as not to be uncomfortable to the operating crews and to clear the tunnel entirely within the minimum time limit for following trains.

1. Blowing with the Train—The Elkhorn Tunnel (N. & W. R.R.) is 3000 ft. long with a section of 235 sq.ft. The tunnel is for single track, with double track extending from each end of the tunnel. It is at the top of a long 2% grade opposed to the heavy coal movement to Norfolk. The grade through the tunnel is 1.4%. The coal trains are handled over the 2% grade approaching the tunnel with three Mallet engines, one at the head and two in the rear. When the train enters the tunnel one of the rear engines is cut off.

The air is blown into the tunnel from the lower end and in the direction the train is moving up-grade, the locomotives being loaded to their tonnage capacity. The velocity of the current is 1700 ft. per min., which is about double the speed of the train. The air current carries the smoke and combustion gases ahead of the engines, making the tunnel clear during the passage of the train. Blowing is done only when the trains are going up-grade through the tunnel.

This method of blowing is most effective and economical in operation only for single-track tunnels of rather small sections, where the locomotives are ordinarily worked to their tonnage capacity and consequently for trains running at speeds of 10 m.p.h. or less. This type has, therefore, a limited use, but it is desirable where the conditions are such as permit its installation.

2. Blowing against the Train—The Big-Bend Tunnel (C. & O. Ry.) is 6500 ft. long, with a section of 250 sq.ft. The grade is 0.4% against the heavy coal movement toward Newport News, and is the ruling grade for the operating division. The current of air is blown against the train, and the effect is merely to dilute the smoke and combustion gases by furnishing a supply of fresh air, which cools and removes the smoke and gases quickly from about the engine cab. After the train has left the tunnel the blowing is continued until the tunnel is clear, which in practicable operation will be within the minimum time interval for following trains.

This method is adapted to tunnels of all sections and for all speeds of trains. The amount of dilution (and therefore the power necessary for its production) is in control of the engineering department. These advantages make the Big-Bend Tunnel method the type for general use.

The accompanying table shows installations of the types of tunnel ventilation recommended above.

*Abstract of the report of the Committee on Roadway.

TUNNEL VENTILATION (UNDER PLANS OF CHAS. S. CHURCHILL AND C. C. WENTWORTH)

Railway	Location of tunnel	Date of installation	Rate of grade	Location of fans	Length, ft.	Section, sq.ft.	Cubic contents, cu.ft.	Cu.ft. of air delivered per minute through tunnel
N. & W.	Elkhorn, Coaldale, W. Va.	6-1901	+1.4% E.	Lower end	3000	S.T. 235	705,000	400,000
C. & O.	Big Bend, E. Hinton, W. Va.	12-1902	+0.4% E.	Upper end	6500	S.T. 250	1,625,000	350,000
Penna.	Gallitzin, W. Altoona, Penn.	4-1905	+0.5% W.	Lower end	3000	S.T. 324	1,166,400	502,000
Penna.	Washington, D. C., station (1)	12-1907	+0.13% S.	Upper end	Tubes 4050, 1 track; 760, 2 to 6 tracks	260(1)	3,371,800	640,000
Penna.	North and East Rivers, N. Y. (2)	9-1910			4135′ to 4357′	225	.....	40,000 to 111,000
B. & O.	Kingwood, Tunnelton, W. Va.	12-1910	+1.0% E.	Lower end	4138	S.T. 352	1,458,000	600,000
C. & O.	Lewis, Alleghany, Va.	6-1911	+1.14% W.	Lower end	4026	S.T. 318	1,280,200	508,800
N. Y. C.	Weehawken, N. J. (3)	9-1911	+0.25% E.	Lower end	4865	D.T. 460	2,047,200	512,000
Penna.	B. & P. Tunnel, Baltimore, Md. (4)	9-1911	+1.32% S.	Upper end	4063	D.T. 432	2,150,000	500,000
C. G. W.	Winston, Ill. (5)	5-1911	+1.00% E.	Lower end	2500	S.T. 282	705,000	300,000
Virginia	Alleghany Tunnel	In progress	+1.22% E.	Lower end	5148	S.T. 360	1,900,000	590,000
No. Pac.	Mullan, Mont.	In progress	+2.00% W.	Lower end	3899	S.T. 283	1,103,000	550,000
N. & W.	Horseshoe	In progress	+0.18% E.	Upper end	3291	S.T. 300	1,000,000	540,000
No. Pac.	Stampede, Wash.	In progress	+0.74% E. +0.20% W.	Lower end	9844	S.T. 310	3,150,000	540,000

1 Tubes, 4050 ft. one track; 760 ft. 2 to 6 tracks. Section for two tubes, 520 sq.ft. station end variable.
2 Special installation of 14 fans for emergency.
3 144 trains per day.
4 193 trains per day.
5 Only one fan installed: 25 trains per day.

The Mechanical Handling of Freight

The use of mechanical means of handling freight is becoming general in manufacturing and industrial plants, but is making slow progress in regard to railway freight stations. It is in these stations that such appliances would be of great advantage (as to facility and economy) if they could be adapted satisfactorily to the special conditions but therein lies the difficulty. The report of the Yards and Terminals Committee, presented at the annual meeting of the American Railway Engineering Association, points out that the difficulty in the application of mechanical conveying devices to freight houses is not in devising such appliances, but in adapting them to conditions of handling where the sizes and weights of packages are of infinite variety and where there are numerous points for receiving and delivering the packages.

In cases where loading and discharge are at fixed points, as in a warehouse or an industrial plant, it is simply a question of adopting one of several forms of conveyors. But it is a very different problem to handle freight which is delivered at a dozen or a score of team doorways (or an equal number of points along a platform), and which must be distributed among a still larger number of cars. So far the nearest approach to the solution of this problem appears to be the introduc-

tion of small motor trucks as a substitute for hand trucks, thus obtaining the flexibility and independence of the trucking system, while increasing the capacity and speed of movement.

About three years ago the Missouri, Kansas & Texas Ry. adopted the electric telfer system for a new double-deck freight station at St. Louis, having the tracks on the lower floor and the team driveways on the upper floor. The telfers were on the upper floor, but raised and lowered the trucks through openings over the train platforms. This very complete installation was described in ENGINEERING NEWS, June 29, 1911. It is rather discouraging to find that this has now been abandoned, and the reasons for this action are stated by S. B. Fisher (M. K. & T. Ry.) in the committee's report as follows:

> Our company has abandoned the method of handling freight by telfers, as our freight was of such a miscellaneous character and with such unhandy packages that we could not handle it economically with this system. I think, however, the principal difficulty is that our men were not educated enough for the handling of this freight, and that we were too far in advance of the times. It is true that with the outbound freight we had the principal difficulty. We found a great deal of breakage, and freight shipped to wrong destinations under this system.

In regard to foreign practice, it is of interest to note that the Lancashire & Yorkshire Ry. (England) has several freight sheds fitted with fast overhead electric cranes of 1680- to 3360-lb. capacity. The bridge is composed of a pair of parallel-boom horizontal trusses, with the hoisting trolley traveling on the lower booms. Electric walking cranes are used in a warehouse. The mast is mounted on a frame with wheels traveling on a single rail in the floor, while the head rides in guides on the girders; it carries a revolving boom.

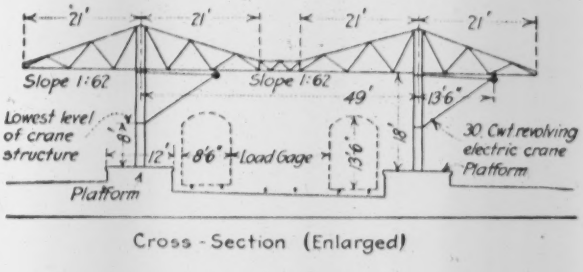
The South Australian Government Railways are equipping the new freight sheds at Adelaide with 1½-ton electric revolving cranes. The accompanying cut shows a plan and section of a three-track outbound freight shed with a driveway on each side. Each row of cranes serves one track and driveway. The cranes have a radius of 13½ ft., and are spaced 80 ft. apart along the platforms, being fitted to the steel columns which support the roof. The mast is a rectangular built-up frame inclosing the column and carrying the motor and gearing, and its lowest point is 8 ft. above the platform. The roof framing of the shed is of novel design.

At steamship piers, motor trucks and conveyors of different kinds are used for handling freight and cargo. But machinery for handling ships' cargo is installed by port authorities in this country to a much smaller extent than in Europe. The report shows that at Liverpool the harbor board has about 130 hydraulic traveling cranes of 1½-ton capacity, mounted on the roofs of the sheds, 20 similar electric cranes, 40 hydraulic wall cranes of 1-ton capacity, and numerous steam and hydraulic cranes of 3 to 100-tons capacity, besides various coaling cranes. The roof cranes avoid interference with the space on the dock front.

At the Manchester docks, the Manchester Ship Canal has 53 hydraulic, 64 steam and 109 electric cranes, varying in radius from 16 to 40 ft., with a lifting capacity of from 1 to 10 tons, to a height from rail level of from 13 ft. to 50 ft. There is also a 30-ton steam crane and a pontoon sheers capable of dealing with weights up to 250 tons, with a lift of 21 ft. An appliance of great utility in connection with the electric cranes is a portable control apparatus. The crane operator carries a small controller connected to the crane by a light cable, so that he can stand at the ship's hatch and keep the load in sight while having control over the hoisting, lowering and swinging movements. The report refers also to the crane equipment at the Hamburg docks, described in ENGINEERING NEWS, July 31, 1913.

The handling of mail, baggage and express matter at stations is a special phase of the conveyor problem. For carrying mail bags from trains some large stations have conveyor belts in covered troughs between the tracks, and a little below the rail level. When a train arrives, sections of the cover are removed, opposite the mail-car doors, and the bags are thrown down upon the belt. Spiral chutes for lowering mail bags and hand baggage are in use also.

Practically the only method of handling train baggage by power is by the use of electric motor trucks. The operation of any trucks on passenger platforms is always more or less of a nuisance and the report shows that in some cases where baggage is handled beneath the train



Cross-Section (Enlarged)

PLAN AND SECTION OF FREIGHT HOUSE EQUIPPED WITH REVOLVING ELECTRIC CRANES; SOUTH AUSTRALIAN GOVERNMENT RAILWAYS

floor, the trucks still have to run from the baggage cars along the platforms to the elevators, thus blocking the stream of passengers from the train. The movement of baggage should be restricted as far as possible to subways, overhead lines and special platforms between the tracks.

An example of the use of conveyors for express matter is afforded by the American Express Co.'s station at W. 33rd St. and 10th Ave., New York. The loaded wagons are backed against a platform served by a 40-in. belt conveyor 555 ft. long, placed 7 ft. above the platform and 3 ft. back from its edge. The smaller packages are thrown upon this belt, which runs at a speed of 90 ft. per min. At the end of this conveyor the packages slide down a short chute to another 40-in. belt conveyor, 66 ft. long, inclined at 20° so as to deliver the packages to the upper floor. There the packages are discharged upon the apex of a revolving cone 22 ft. diameter, from the base of which they are taken by the sorters.

TYPES OF CONVEYORS FOR FREIGHT HANDLING

TELFERAGE—This system of handling goods by motor trolley hoists on overhead runways is in use at a number of industrial plants, and at a few freight piers.

BELT AND PLATFORM CONVEYORS—These are of numerous designs adapted to various purposes, and are used very extensively for both horizontal and inclined movements, for short and long distances. In some cases they extend across bridges from a warehouse to a pier or dock front, and by a hinged extension at the end the packages can be deliv-

ered or loaded at the ship's hatch. One form of cargo-unloading conveyor has its belt carried on a truss attached to a tower or frame, which travels along the dock wall. The attachment is hinged to the tower and has the outer end supported by cables, so that the inclination can be varied to suit the level of the ship or barge.

GRAVITY CONVEYORS—These consist of rollers carried in side frames mounted on legs, and for portable use the conveyor is made in sections (straight and curved) 6 or 8 ft. long, with a grade of about 4%. They can be used only for a down-grade movement, but for long runs an automatic motor-driven inclined or vertical elevator raises the packages to the top of the gravity run. Spiral conveyors are made in the same way, and where packages of various kinds are used they have the advantage that all packages move at approximately the same speed, while in spiral sliding chutes the speed varies with the weight and a heavy package may overtake and damage a lighter package.

GRAVITY CHUTES—Straight and spiral inclined chutes are used extensively in stores, warehouses, etc.; also at some railway stations for lowering mail sacks and light baggage. Open chutes or troughs are used for the larger and heavier class of packages, but for lighter packages the chute is a steel spiral inclosed in a steel cylinder, with loading doors or discharging chutes at the different floors. The openings are equipped with automatic fire doors.

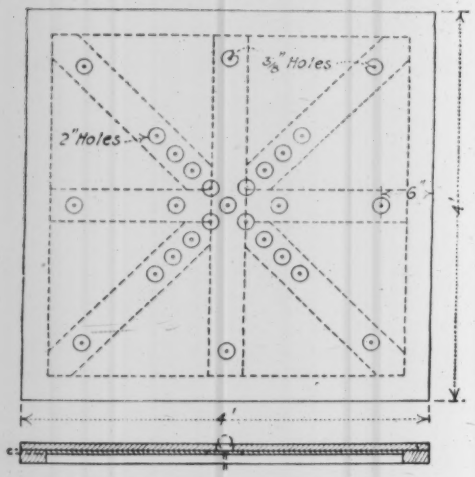


FIG. 1

FIG. 1. DEVICE FOR MEASURING DISTRIBUTION OF PRESSURE ON ROADBED

TRUCK CONVEYORS—To facilitate the movement of hand trucks, there are different makes of traveling chains and platforms, the chains having arms or lugs to engage the trucks. These are used mainly at steamship piers, on the inclined gangways from the floor to the level of the ship's side ports. The trucker keeps hold of his truck in the usual way, and in some cases the chain forms part of an endless traveling platform on which the men stand, but usually the men walk beside the chain.

MOTOR TRUCKS—The use of motor trucks of about 1-ton capacity for handling freight and baggage is on the increase. A special form of motor truck has an electrically operated crane capable of handling loads up to one ton. This can load the truck, carry the load to a wagon, and place the load on the wagon. At the Stuyvesant docks of the Illinois Central R.R., at New Orleans, four 2-ton storage-battery electric trucks are used, running at 5 to 8 m.p.h. For the first six months of 1913, these handled 21,953 tons, with a haul of 530 to 840 ft., and loads of 2000 to 3800 lb. The cost per ton of freight handled was 15.49c., as compared with 17.7c. with the hand trucks.

The Protection of Iron and Steel against corrosion was the subject of a large part of the report of the Committee on Iron and Steel Structures. Most of this report was devoted to reprints of the reports of the American Society for Testing Materials on paints and other protective coatings; the remainder was on concrete encasement (see p. 621 of this issue).

Determination of Allowable Unit Pressures on Railway Roadbed*

BY J. R. W. AMBROSE†

In making this investigation, we naturally [illegible] into the question of load distribution through the ballast [illegible]wise the ties and rails, and, therefore, must consider [illegible] distribution of the load from the rail to the subsoil. We [illegible] first intercept this distribution at the subgrade, in order [illegible] determine what loading is delivered to the roadbed. The first point to determine is the method by which the necessary data can be obtained, and it was with this in view that the following more or less crude experiments were performed.

The first attempt was made to utilize the principle of the electrical resistance of powdered carbon upon the idea that the resistance varied inversely as the pressure. A table was constructed 4 ft. square and 1¼ in. thick. It has diagonal rows of holes, 2 in. diameter, ¾ in. deep and spaced 3 in. c. to c., beginning with one in the center of the table. In the center of each depression through to the bottom is a ⅛-in. hole (Fig. 1).

In the bottom of each hole is placed a copper disk connected with a terminal at the outer edge of the table, and the space then filled with powdered electric-light carbon mixed with powdered charcoal in proportion of 2 to 1, respectively. On top of this mixture and flush with the top of the table was placed a second copper disk connected to a terminal near the former one at the outer edge of the table. The resistance of the carbon in each hole was measured before any loading was applied.

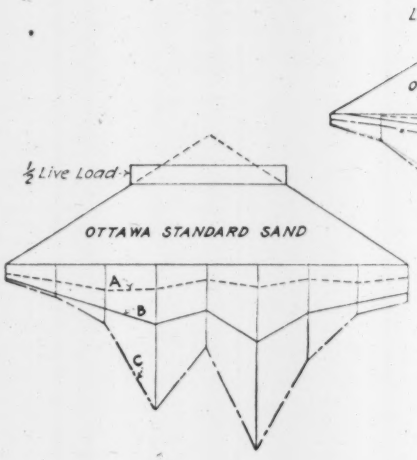


FIG 2

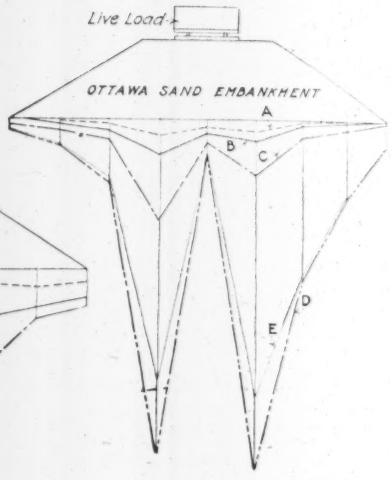


FIG. 3

FIGS. 2 AND 3. DIAGRAMS OF TESTS OF DISTRIBUTION OF PRESSURE ON ROADBED

Then about 100 lb. of Ottawa standard sand was placed on the table in the form of a cone with its center coincident with the center of the table. The resistance in the various pockets was again taken and the difference noted. This was continued under various conditions until it was found that the method was too delicate, although certain information was obtained which showed conclusively that the maximum pressure in the bank was not at its center, and also that at a certain neight an arch was formed in the material which transferred the presure to the side, rather than directly downward, and in trying to destroy this arch by vibrating the table, the value of the resisting quality of the carbon was also destroyed. Therefore this method was abandoned.

The second method attempted was by using the same table and placing in each of the depressions a small rubber bulb, which in turn was connected by rubber tubing to a glass tube.

*Extracts from the report of the Committee on Roadway. The report states that nothing further can be done toward defining allowable unit pressures until experiments have been made under actual traffic conditions, and arrangements have been made to start such experimental work.

†Engineer of Grade Separation, Grand Trunk Ry., Toronto, Canada.

held in a rack at the side, and just above the table. Each bulb was filled with water, and the level of the water in all of the glass tubes kept the same before any loading was applied. Then using Ottawa standard sand, a cone was built over the center of the table by applying the sand in 10-lb. lots and after each lot was applied, a reading in the tube was taken.

The result of these various loads is shown in Fig. 2. Each of the vertical lines represents a point of application upon a bulb, and also the corresponding glass tube. The dotted line A, marked dead load represents the result after 100 lb. of sand had been applied. Then a block of iron weighing 31½ lb. was applied to the top of the cone, the solid black line B showing the result. Then by slightly jarring the table in order to break the arch, we got the result shown in the dot and the dash line C. It will be noted that in all instances the pressure at the center is considerably less than that of either side. Similar results were obtained with sand taken from the lake shore.

Fig. 3 shows the result of an experiment made by building an embankment to scale ½ in. to 1 ft., the embankment being 5 in. high, 6 in. wide on top and having 1½ to 1 slope, which represents 10-ft. bank with a 16-ft. roadway. The bank was built so that the line of tubes ran at right angles to its center line. A small track was built to the same scale and placed on top of the embankment. A small board was fitted with wedge-shaped cleats to represent the points of application of loads from an E-50 engine. Upon these was placed the same iron weight of 31½ lb.

In Fig. 3 the results obtained will be noted: 1, the dotted line A shows the load of the embankment; 2, the solid black line B shows the load after the weight was applied; 3, the dot and dash line C shows the dead load plus the live load after the table was slightly jarred, thus breaking down the arch; 4, the double dot and dash line D represents the total load after the weight has been alternately taken off and on, with the idea of getting the effect of impact. This was continued until the bank showed evidence of failure by bulging out on either side. The fine solid line E indicates the result after the live load was finally removed and the table slightly jarred.

There is plenty of food for thought in the results shown in Fig 3, especially when one thinks of how the rail loads seem to affect the roadbed directly underneath them, and not in the center. While the preceding method seems to show good results for static loads, it would not do for recording loads transmitted from a fast-moving train, as the time required for the water or mercury to return from any given reading to the normal position is quite perceptible.

⁂

Wave Motion of Roadbed*

By James E. Howard†

One feature in track maintenance deserves special consideration. It is the exposure and alternate stresses due to variation in load. The difference is very pronounced between repeated stresses and static loading, and this is an obstacle to judging of track conditions in the light of experience in foundation work.

I have had opportunity to make a number of observations in the behavior of the surface of the roadbed as affected by the weights of engines and trains. The observations were made on the Missouri Pacific Ry., through the kindness of J. R. Leighty, Engineer, Maintenance of Way, a few additional observations having been made on the Burlington R.R.

The depression on the roadbed and adjacent ground is measurable for a distance of at least 30 ft. from the center line of the track on which the train passes. Within a shorter distance, say 10 ft., the difference in depression between that of heavy and of lightweight cars is noticeable. This is the case of trains moving at 6 to 10 m.p.h., and at such speeds the partial recovery between trucks of the same car may be noted.

These cases are where the level was placed at right angles to the direction of the length of the track. When parallel to the track the boundary of the affected zone of depression may be noted, and the reversal in the direction of the slope of the ground ascertained when the engine gets abreast and then advances beyond the place of observation.

One observation of interest, if it is confirmed, refers to the apparent rebound of the roadbed after the passage of a train at high speed. In the one case observed the train caused first a depression, then immediately after the train got by an elevation above the normal, which subsided in a short time, a few minutes, and came to rest at its normal elevation. Possibly the relative effects of different speeds can be judged of in some such manner as this.

The rate of travel of wave movements was also noted, that is, an appreciable interval of time is necessary for the roadbed to transmit a wave of depression from the track to places of observation at different distances away.

⁂

Report on Iron and Steel Structures*

The principal subjects dealt with by the Committee on Iron and Steel Structures during the past year, and the action taken by the committee, are as follows:

Methods of protection of iron and steel structures against corrosion. (Final report.)

Design of built-up columns (Progress report).

Design and length of turntables (Progress).

Movable bridges (No result; discontinuance suggested).

Secondary stresses (Report on calculations and experiments).

Signals and interlocking for movable bridges (Final report).

Bridge clearances (Inquiries made).

Secondary Stresses

The most elaborate of the several reports rendered by the committee was that on Secondary Stresses, handled by a subcommittee composed of F. E. Turneaure, C. L. Crandall, F. O. Dufour and Albert Reichmann.

Experiments were made on five bridges, mainly during the summer of 1911. Secondary stresses in various members of each bridge were measured, under known loading. They are summarized in a table below (compiled from figures given in the committee's report).

Most of the observed secondary stresses are of the class caused by distortion of the truss network in its own plane. The committee recognizes four other kinds of secondary stress, however. The five classes are:

(1) Bending stresses in the plane of the main truss due to rigidity of joints, eccentricity of joints, and weight of members.

(2) Bending stresses in members of a transverse frame due to the deflection of floorbeams and primary stresses in posts.

(3) Stresses in a horizontal plane due to longitudinal deformation of chords, especially the stresses in floorbeam end connections.

(4) Variation of axial stress in different elements of a member.

(5) Stresses due to vibration of individual members.

The committee regards classes 1, 2, and to some extent class 3, as susceptible to calculation, with definite and reliable results. Classes 4 and 5 are not readily calculable; their influence, however, has been observed in the course of the experimental work of the committee.

Calculated Secondary Stresses—The committee gives calculated secondary stresses in a number of typical railway bridges. The figures contain various instructive features.

In a deck Pratt truss 247 ft. long, 10 panels, 40 ft. deep, pin-connected except for riveted top chords, the secondary bending in the top chord ranges from 5 to

*In this regard the Committee on Roadway states that the depression under traffic and subsequent recovery of the embankment and surrounding soil observed, indicating an elastic nature or a wavelike motion of the soil, suggests that the scope of the experimental tests originally contemplated by the committee may have to be widened.

†Interstate Commerce Commission, Washington, D. C.

*Committee XV on Iron and Steel Structures is headed by A. J. Himes, Chairman. Its work is divided among ten subcommittees, reporting separately on the specific subjects assigned to them.

OBSERVED SECONDARY STRESSES IN VARIOUS BRIDGE TRUSSES

Committee of American Railway Engineering Association

[Stresses in per cent. of primary stresses]

Location of measurement	160-ft. Pratt %	176½-ft. Pratt %	104-ft. Pony Pratt %	182½-ft. Camel-back %	105-ft. Pony-Warren [Calculated] %	105-ft. Pony-Warren [Observed] %
End Post						
Lower end	19	23	7	20	[10]	5
Middle	....	....	....	32		30
Upper end	....	....	22	24	[12]	13
Top chord						
Hip	3	....	75	....	[9]	
Second joint	6–52	....	29	23–29	[20–23]	9
Third joint	7–16	....	10	....	[22]	27–31
Bottom Chord						
Near shoe	....	57	10	....	[16]	
At hip hanger	....	....	24	....	[22–32]	24–18
Second joint	....	....	....	....	[20–40]	23–15
Third joint	....	....	33	....	[40]	28–30
Fourth joint	....	....	....	....	[30]	26
Webs						
First diagonal—top					[3]	6
First diagonal—bottom						13
Second diagonal—bottom					[27]	36
Second diagonal—top					[1]	27
Third diagonal—top					[10]	25
Third diagonal—bottom					[10]	9

Note:—160-ft. Pratt: Riveted through truss. 31 ft. deep, 6 panels, span 159 ft. 9 in. c. to c. end bearings. End diagonals are eyebars, connected by 6-in. pins. Bridge is skewed 10 ft. in its width of 17 ft.

176½-ft. Pratt: Pin-connected through Pratt truss, 29 ft. deep, 8 panels (end panel 16½ ft., others 20½ ft.), span 176 ft. 6 in. c. to c. end pins. Diagonals are eyebars; counters in middle panel.

104-ft. Pony Pratt: Pony Pratt truss bridge 12 ft. deep, with chords riveted continuous, end joint pins, diagonals eyebars. Six panels 17 ft. 4 in., 104 ft. c. to c. end pins.

182½-ft. Camel-back: Riveted through truss, Pratt system of webbing, curved top chord; 40 ft. 6 in. center depth, 34 ft. 6 in. depth at hip, 7 panels 26 ft. ¾ in., 182 ft. 5½ in. Posts and diagonals each 4 angles and 2 plates.

105-ft. Pony-Warren: Riveted pony truss, Warren web with vertical hangers and struts. Depth 10 ft., 8 panels 13 ft. 1½ in., 105 ft. c. to c. bearings.

13%, except in the end panel and the panel nearest the middle, where the secondary stresses rise to 24 and 33% of the primary stresses. By lengthening the middle vertical $^3/_{64}$ in. (springing it into place), the excessive secondary stress in the top chord is reduced to normal, 16%.

In a 396-ft. Pettit through truss 60 ft. deep at center, 32 ft. at hip, with 8 main or 16 subpanels, pin-connected, except for riveted top chord, the top-chord secondary bending remains below 20% except at the three main and subpanel points nearest the center, where the stress rises to above 60% of the primary stress. By omitting the substruts to the top chord, the secondary stress is reduced to less than 20%.

In a 160-ft. riveted 6-panel through truss, 31 ft. deep, designed in one case as a Pratt truss and in another case as a Warren truss with verticals, the secondary stresses remain generally below 20%, except that in the bottom chord of the Warren the secondary stress near the hangers is about 25%.

In a parallel-chord riveted through truss, of subpaneled Warren type, 31½ ft. deep, having 12 subpanels of 12 ft. 9¼ in. each, very heavy secondary stresses were computed. At the subpanel points of the bottom chord, the secondary stress rises to about 60% of the primary stress. In the end post, the secondary stress at the midpoint, where it is engaged by a collision strut, is about 50%. The main diagonals have secondaries as high as 40% at the middle point, where the subpanel members are attached. The top chord secondary stresses are lower, with a maximum below 30% at the hip.

A double-intersection Warren truss of 150-ft. length, with subverticals dropped from the intersection of the two sets of diagonals to form subpanels 8 ft. 4 in. long, with truss depth 29 ft., shows very high secondary stresses. The bottom-chord secondaries run from 70% to 100%. The top-chord panels not being subdivided, on the other hand, the secondaries there are low, with a maximum of 26% at the hip. The web secondaries run up to 30%-60% of the primary stresses. Curiously enough, the secondary stresses in the end post are well below 30% at the collision strut, but are as much as 48% at the top.

Calculations on several viaduct towers showed a similar variety as in the case of trusses. The stresses depend considerably on the web system. When a diagonal web system without horizontal members is employed, analysis shows that an even number of stories is objectionable for the high secondary stresses, which are suppressed in case of an odd number of stories because the successive joints counteract each other's influence in producing bending.

The committee expresses the general conclusion that secondary stresses due to the distortion of the truss network in its own plane should not exceed 40% of the primary stresses when the width (depth) of member is one-tenth the length; or, generally, the ratio of secondary to primary stress should not exceed $4 \times \frac{width}{length}$. Secondary stresses may be expected to be lower when subdivided panels are *not* used. In the bottom chords of through trusses the secondary stress may be as high as $5 \times \frac{width}{length}$, but, as the ratio of width to length can be kept lower than in compression members, the total secondary percentage ought to be as low as 30% to 35%.

Some other principles of secondary stresses are stated by the committee:

At subhangers or substruts to the loaded chords, the secondary stresses in the adjacent chord members are likely to be considerably larger than elsewhere. Secondary stresses in subdivided-panel trusses are, therefore, likely to be very high, especially because the members of such trusses are apt to be deep for their length.

The more uniform the proportions of the truss, the less in general will be the secondary stresses. Sudden changes in length, width, or moment of inertia are likely to result in relatively large secondary stresses.

Trusses consisting of equilateral triangles and without hangers or vertical struts present the most uniform condition and will have in general the lowest secondary stresses. A truss composed of right-angle triangles will show somewhat higher secondary stresses, and such stresses will be large if the ratio of height to panel length is large.

BENDING IN TRANSVERSE FRAMES OF BRIDGE—The committee considers this important source of secondary stress and shows that, from the formula for distortion of a square frame, the usual spacing of track stringers in a single-track bridge makes the ratio of secondary stress

in posts to maximum fiber-stress in center of floorbeam approximately equal to 0.7 to 1.0 times width of post divided by depth of beam. Ordinarily, therefore, the secondary bending in the post is likely to be about 20 to 25% of the bending stress in the center of the beam. Generally speaking, measurements of such secondary stresses have agreed with these conclusions.

CHORD ACTION IN FLOOR—The bending of floorbeams due to the elongation of the bottom chord has frequently been observed. The use of expansion joints in stringer connections in long-span trusses is common practice. Observations on several spans of about 100-ft. length showed maximum horizontal bending stresses in the floorbeams ranging from 1000 to 4000 lb. per sq.in., or percentages of horizontal to vertical bending stress ranging from 15 to about 130%.

OTHER SECONDARY STRESSES—Inequalities of stress in a panel of eyebars have been observed. Variations of 19 and 31% above average of the panel were noted in individual eyebars, but this was only on two bridges, so that much greater variation may possibly occur.

Vibration of long eyebar diagonals have been measured, and it is calculated that in a particular case the observed vibration would correspond to a stress of about 3000 lb. per sq.in. Lower-chord eyebars have not been observed to vibrate materially.

COLUMN TESTS

The committee, after much delay in getting its work started, is having a large number of steel columns tested by the U. S. Bureau of Standards. The first test was made on Jan. 20, 1914. In this work the committee is coöperating with the steel-column committee of the American Society of Civil Engineers, the arrangement between the two committees being such that there is no duplication of work and that the tests made for the two committees will supplement each other.

BRIDGE CLEARANCE DIAGRAMS

A committee has had inquiries made of a large number of railroads as to their attitude in regard to a modification of the association's standard bridge-clearance diagram for the purpose of giving more room for third-rail location. Widely varying opinions were expressed, and the committee has not done anything to sift these out or bring them together. The replies indicate some sentiment toward a *general* enlargement of bridge clearances.

CONCRETE ENCASEMENT OF STEELWORK

As a part of a report on the protection of iron and steel structures against corrosion, the committee presented a brief discussion of the encasement of steel structures in concrete. The data for the discussion was obtained from four railways which have employed this method of protecting their metal structures from locomotive gases.

The conclusions of the committee are as follows:

Concrete encasement as a protective agent for that portion of steel structures exposed to the blast and gases of locomotives has come into use on account of the trouble experienced with paint and to the cost of maintenance of the same.

That concrete properly applied is an ideal protection will, we believe, be conceded by everyone interested, even though they do not generally use it. The use of the concrete encasement is in a way limited by railroads to undercrossings and to city bridges where the headroom is close and the railroad traffic heavy.

Painting—In the above locations protecting floors by the use of paint is at best unsatisfactory and the cost while varying with the conditions will be somewhere in the neighborhood of $1.25 per ton per year. A fair average relation of weight to area is 0.065 sq.ft. per lb. of metal, this giving, using the above value, a cost of 0.96c. per sq.ft., per year, for painting.

Poured Encasement—If the floor is protected by the use of concrete encasement poured in place, the cost per square foot is shown to be approximately 25c. per sq.ft., the encasement being 3 in. in thickness.

Gun Encasement—Encasement of the floor by use of the cement gun, the encasement being 3 in. in thickness, is shown to be approximately 23c. per sq.ft.

The information from the various railways, upon which the above summary was based is, in brief, as follows:

NEW YORK CENTRAL & HUDSON RIVER R.R. (through W. F. Jordan)—The cement gun was used at the Grand Central Terminal, New York City, for fireproofing and protecting a part of the steel structure. The yard is in two stories, the upper tracks being supported on a steel structure with concrete jack-arches. It was necessary to get the upper tracks in service at an early date, so the fireproofing of the exposed parts of the steel below the jack-arches was not done at the time the floor was built.

The lower parts of the beams, the girders and columns were fireproofed with the cement gun, using a minimum thickness of 2 in.; the average thickness is from 2½ to 3 in., as in the angles and around the stiffeners there is generally more than the minimum thickness.

The fireproofing is reinforced with a wire mesh, 1½x1½ in. of No. 12 wires; this is attached to ¼-in. rods, which are bent around the steel and fastened to it.

The mixture was generally 1:3, but in cool weather, and where the steel is subject to vibrations from the trains running on it, a 1:2 mixture was found to be more economical, as it is not as likely to drop off. It was necessary with this machine to use fine sand, as sand with pebbles in it clogs the hose; all of the sand, therefore, had to be carefully screened.

We found that a cubic foot of 1:3 mixture, when weighed in a box of 1 cu.ft. capacity, after being moderately shaken down, weighed 93 lb.; if this mixture is wet and applied with a trowel, after setting it will weigh 127 lb.; when shot through a cement gun onto a steel structure and set up, it weighs 144 lb.

In applying the mixture of sand and cement with the cement gun from 20 to 25% of it is lost. Some bounces off as it strikes the structure, some is shot by the steel in working around the angles and to get a smooth surface the mason scrapes off the irregularities, and to get a good surface it is floated.

The labor required to operate one machine was as follows: One foreman; one operator of the machine; one nozzleman; two masons for floating; four laborers screening, mixing and charging the machines. Carpenters were used when necessary to erect scaffolds.

One of these machines used compressed air to the amount of 100 ft. of free air per minute at a pressure from 35 to 40 lb. The hose through which the mixture was conveyed wore out quite rapidly and renewals amount to about $1 per day.

KANSAS CITY TERMINAL RY. (through G. E. Tebbetts)—When the Kansas City Terminal Ry. Co. took over the Kansas City Belt Ry. to be used as their main line, there were among other structures four overhead highway viaducts which were of the encased type, i.e., having the floor system protected by concrete.

One of the bridges, erected in 1903, was of a through-girder type, 64 ft. long with suspended floor beams, the bottom flanges of the stringers flush with the bottom flanges of the girders. The plans called for 1½ in. of encasement held in place by No. 10 gage, 3-in. mesh, expanded metal and ½-in. bolts, mortar to be 1:2:4 mixture. The roadway floor and sidewalk to be 1:2:4 concrete 5 in. thick reinforced with expanded metal. All steel encased unpainted.

The bridge was constructed as described, except that the encasement varied from 1½ in. to 3 in. thickness, in general being 2 in. The concrete was put in dry and tamped and the mortar for the encasement was also made stiff, being rammed into the forms. The bottom board was held in place by bolts, and after the forms had been filled the bolts were tightened to force the mortar onto the steel work. No waterproofing was used. Overhead clearance was 19 ft.

Recent inspection showed the encasement on underside of floorbeams, stringers and girders over main track nearly all gone. The encasement over industry tracks was in a little

better condition but concrete was missing in quite a few places, notably lower flanges. The lower surface of floor was wet. Samples of concrete were taken and tested for excess of sulphur, but no excess was found.

It was concluded that most of the trouble was due to the seeping of water through the cracks in the concrete floor and also between the encasement and the steel; this action loosening and cracking the concrete and rusting the reinforcement, finally causing the concrete to drop off.

On the three structures erected in 1906 the encasement work was in about the same condition as the one above described, the cause seeming to be the same, i.e., the seeping of water down between the steel and the concrete.

On the new structures, the Kansas City Terminal Ry. Co. is building, the encasement is applied in the majority of cases by use of the cement gun.

A comparison of costs by cement-gun work and by pouring in forms shows a saving of 2c. per sq.ft. in favor of the gun work over the poured encasement, and it might be stated that since this estimate was made we have received bids on actual work that check very closely with the above.

The steelwork to be encased was designed with open holes 1½ in. in diameter in webs, stiffeners and flanges, so that in placing and attaching the reinforcement there would be ample provision for rigid attachment to the structure. In attaching reinforcement to girder webs and other large surfaces, the bars were placed on small V-shaped iron saddles and wired through the webs to each other. On flanges the rods were run through steel eye-bolts attached to the lower flange, the mesh being attached to the bars by wiring. At the junction of the concrete encasement with the floor, which is also of concrete, a splice was provided by use of mesh placed in the floor previously cast, this splice being 4 in. in width.

The steel girders were shipped from the shops with a shop coat of linseed oil, which was removed by the use of a caustic soda wash before encasement was started. All rust spots were removed with a wire brush.

Our experience has shown that the 1:3 mixture placed in the gun gives a resulting mortar of approximately 1:2½, this change being due to loss of sand. The sand must be nearly dry, the dryer the better, a mixture of coarse and fine grains giving better results with considerably less loss, than either the coarse or fine alone.

The sand must be screened as particles over ⅛ in. in diameter clog the gun and cause serious delays.

The compressor should be a machine of very ample capacity and an intermediate air storage tank is an advantage.

It was found that it was very difficult to encase the lower flange of a girder, especially so the lower face, and in our work we cast this portion in quite a few cases.

It was also a difficult proposition to get a good, clean job around stiffeners and sidewalk bracket members. On the brackets V-shaped forms were made and used as a backing for the gun work. As to finish, the appearance is fairly good, though far from the smooth, even lines of cast work and a great deal depends upon the finisher as to the final appearance.

One great advantage of the cement-gun work, especially so in a large terminal proposition, is that the viaduct can be put in service and the encasement work performed afterward when convenient without any material trouble.

Care has been taken in all the work on this terminal to build and waterproof the bridge floors so as to prevent the seepage of water onto the concrete, or encasement work, and we believe that waterproofing is an essential in good encasement work.

Blast Boards and Smoke Shields

Further inquiry from railways brought out the fact that when the locomotive stack comes near to the concrete encasement the blast of gases and smoke is so severe as to require some interposed protection such as steel, wood or composition plates. The reports are as follows:

CENTRAL RAILROAD OF NEW JERSEY (through J. J. Yates)—It is our practice to protect the steel of highway bridges or structures over our tracks by encasing in concrete. Where in close proximity and subjected to the blast of the exhaust from the stacks of locomotives, this has not proved altogether satisfactory.

A concrete floor was installed in our bridge over the Pennsylvania R.R., at Newark, N. J., at which point there is only a clearance of about 12 in. above the stack. Within six months' time the concrete over the exhaust had been blown off to a depth of about 2 in. and it is now contemplated to use a ⅛-in. steel plate to protect the concrete. This type of steel-plate protection was installed about two years ago by the Pennsylvania R.R. when they renewed their bridge over our tracks at Elizabeth, N. J., the previous bridge being so badly disintegrated by gases as to require renewal. Up to the present time this has proven very satisfactory and looks as if were still good for two or three years. The original bridge was built about 1892.

BOSTON & ALBANY R.R. (through W. F. Sc[illegible]—We have built at Tremont St., Boston, a bridge over [illegible] tracks of the Boston & Albany R.R. The minimum clear[illegible] from top of rail under side of bridge is 15 ft. 1¾ in. It is evident, therefore, that the top of stack of the highest locomotive passes the bridge by but a few inches clearance. The old structure was of the usual open-floor type, with pony trusses, was built in 1889 and when removed was practically deteriorated to not less than 50% of the original sections, where exposed to gases.

The new structure is of plate girders, with a floor of total depth of about 2 ft. 1 in., consisting of 15-in. beams spaced 1 ft. 6 in. c. to c. and incased entirely in concrete to form a solid slab, upon which the rails of the Street Railway Co. and the paving are laid. The concrete is supported under the flanges of the beams by a network of ¼-in. rods attached to the beams by means of thin hangers of strap steel 2 X ½-in. section hooked over the top flanges.

It was very evident that under the severe conditions existing at this structure, the concrete protection would soon be worn away by blast action. To prevent this, we embedded in the concrete over the center line of each track a series of cast-iron blast guards 1 in. thick by 20 in. wide and in convenient lengths, attaching these to the concrete by means of hook anchors into the slab. The exposed surface of the cast iron was chilled in order to harden it.

This blast guard construction has demonstrated that it will be effective indefinitely in protecting the concrete undersurface. The blast strikes the plate and is deflected horizontally as intended.

KANSAS CITY TERMINAL RY. (through G. E. Tebbetts)—Up to the present time we have not put into use blast boards on the work in hand, but the use of a ½-in. asbestos board 2 4in. wide over the center line of each track is contemplated and will be put into service within the next few months.

The old structures on the Kansas City Belt Ry. had, in quite a few cases, headroom varying from 17 to 20 ft. and were built over the main line where the grade was 1½%, so that they were subject to a very violent sand-blast action from exhaust. On inspection it was found that the girder flanges and other portions of floor system over the uphill tracks were practically worn away by the action of the exhaust, the wooden floor joists being worn away to a depth of about 2 in. by 2 ft. in width over the center line of tracks.

Several materials were considered for experimental purposes and it was finally decided to try asbestos board in two very severe locations. The boards were placed at a height of 18 ft. above the rail at Grand Ave. and Troost Ave. temporary bridges. At the above points the grade of the tracks was 1½% and the blast action very severe. The boards were left in service for about eleven months and were examined every month. It was found that there was practically no cutting action and the boards were finally removed when the temporary bridges were taken down.

On the showing of the experiment, asbestos blast boards have been adopted for use on the terminal work.

Gravity Switching Yards

The use of gravity or hump switching for the classification of freight cars, in order to group together those for certain destinations or with certain commodities, is increasing in the case of large and busy yards, and is one of the subjects discussed in the report of the Committee on Yards and Terminals. The report lists 95 freight yards of this class on 30 railway systms, 34 of these yards being on the Pennsylvania System. In regard to certain operating features of these yards, we have compiled the committee's information in the following table:

	No. of yards	Average per yard
Cost per car for hump-yard operation	28	21.2c.
Cost per car for flat-yard operation	11	22.9c.
Number of cars per hour over the hump	22	72
Number of cars per 24 hours over the hump	24	1973
Scales on switching hump	29	19 yes
Number of cars daily to warrant use of hump yard	24	800
Is a departure yard used	29*	16 yes

*Reports from 28 of the yards favor the use of departure yards.

One of the most important elements in the design of a gravity yard is the determination of the rate of grade for the descending or accelerating grades from the summit of the hump, upon which the cars acquire the momentum which carries them along the classification ladder and into the classification tracks. It is difficult to determine this with any degree of exactnesss since conditions vary in different yards, and factors of location and traffic affect the car movement. In colder districts and where the cars are mainly empty, the grades must be somewhat steeper than in warmer climate and where the cars are mainly loaded.

The grades must be sufficiently steep to insure that each car will run readily to any part of the classification tracks (under control of the car rider or brakeman), but not steep enough to result in injury to the cars and loading due to the moving cars striking the standing cars with undue force. Some officials consider that there is more damage of this kind in gravity yards than in flat yards, but this is not general experience or opinion, and there is no good reason why it should be the case.

The arrangement of grades previously submitted by the committee and adopted by the Association as "recommended practice" (with the track scale on the grade) is as follows:

1. Where cars are largely empty: 2% for 60 ft. and 4% for 50 ft., followed by 1% on the ladder and 0.5% through the classification tracks.
2. Where cars are largely loaded: the same grades, but the 4% grade may be shortened (to not less than 25 ft.), and the two following grades should be at least 0.8% and 0.4%, respectively.
3. The grade over the scale not to exceed 2%.

The committee made inquiry as to proposed changes in the above, but most of the replies were to the effect that no changes were desired. One reply, however, suggested rates of grades as shown by the table at the head of the next column, the horizontal length of incline being 300 ft. in each case, succeeded by 1% grade along the ladder and turnouts.

The principal feature of this arrangement is in reducing the grade over the scale, instead of putting the scale on the 2% grade at the summit. The idea is to check the speed slightly in passing over the scale, the steeper grade above the scale being necessary to start and space the cars. This reduction of grade is followed in many gravity yards.

	Starting	Over scale	Accelerating
Loaded cars; with scale	3% for 35 ft.	0.5% for 50 ft.	2.5% for 215 ft.
Loaded cars; no scale	3% for 100 ft.	.....	1.5% for 200 ft.
Light cars; with scale	3% for 40 ft.	0.5% for 50 ft.	3 % for 210 ft.
Light cars; no scale	3% for 200 ft.	.....	1.5% for 100 ft.

The switches are handled usually by hand, by switchmen on the ground; but in some large yards they are operated by power from an elevated cabin or tower. In the latter case, there is usually at the tower switchboard an indicator for each switch, to indicate to the operator if a car has cleared the switch, or has stopped too soon and is fouling the switch. The cars run along the ladder track in quick sucession (as they are uncoupled from the train at the summit), and the switchmen or towermen must be informed as to the track for which each car or cut of cars is intended. This is done very frequently by giving the men a switching list (showing the number of cuts and the track for each), or by chalking the ends of the cars, and sometimes by giving hand or lamp signals.

The replies to the committee's inquiry show that of 29 yards, 20 yards use a switching list, 8 chalk the cars, and at one yard telephones are used, while two or three use hand signals as supplementary.

In regard to cost of operation of gravity switching as compared with flat-yard switching, it is pointed out the gravity yard is built mainly for increased speed and facility of work, rather than for actual economy. Some engineers consider that the cost of operation is no less, while others state that for the same service and conditions the cost would be 50% less than for a flat yard, and the latter would require to be of much larger size.

The minimum business which would warrant the use of a hump yard was stated at 500 to 1000 cars per day in different replies. Two replies stated that this should be determined by the number of switches made or by the number of classifications (rather than the number of cars), the minimum for a hump yard being seven classifications or 800 switches per 24 hours.

Internal Stresses; with Application to Reinforced-Concrete Beams

A Series of Three Related Papers, with Diagrams II. Stress Trajectories

By Charles A. Gilchrist*

SYNOPSIS—Shows trajectories and contours of principal stress. Discusses and derives the curves for the case of bending.

If a point were to move through a stressed body always following the direction of principal stress for all positions it assumes, it would trace some fixed locus, depending upon its initial position. By varying the initial position we might fill the whole area of the body with a family of non-intersecting loci. Another family of curves could be traced for the other principal stress, the two families mutually intersecting at right angles everywhere. Some of these lines or *trajectories* of principal stress for a uniformly loaded simple beam have been accurately plotted in Fig. 4. They give the direction of principal stress for any point but show nothing as to stress intensity.

Fig. 5 shows the trajectories for the unloaded portion of a loaded beam, and it also shows stress intensities by means of a set of *stress contours*, or lines of equal stress. The trajectories and contours here shown are typical of a

*Designing Engineer, Bureau of Navigation, Manila, P. I.

general method for displaying the complete distribution of stress in any stressed body whatever, when the shape, loading and elastic behavior of the body are sufficiently known.

In what follows the "flow" of normal stress as exhibited in Fig. 5 will first be discussed, after which a brief outline of the derivation of the curves will be given. All the figures herein presented are original with the writer.

To make perfectly clear the type of loading we are dealing with, imagine the portion of the beam on the left of the axis of Y as wiped out and a support substituted similar to one of those shown in Fig. 4. The conditions on the right will be in no wise changed. Further than this, it makes no difference how far to the right the beam extends before it gets its load, for the moment at any point depends only upon the shear at Y and the distance of the moment plane from Y. The curves shown will answer for that portion of any beam which is entirely *between* external loads and reactions. A plane of contraflexure is included because it is a plane of symmetry, and the general properties of the curves are better illustrated at such a point than they are at a point of relatively high bending moment.

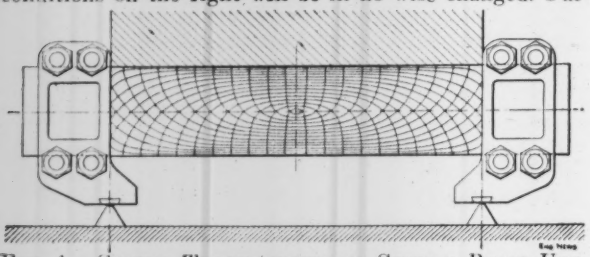


FIG. 4. STRESS TRAJECTORIES IN SIMPLE BEAM UNIFORMLY LOADED

(Vertical compression due to load is neglected.)

The trajectories extending outward in either direction approach indefinitely toward the boundaries of the beam until interrupted by an external load. The boundary of the beam are asymptotes for all trajectories. (Note that the trajectories for distributed load shown in Fig. 4 are not asymptotic.) Beginning with the compression trajectories at the extreme upper right, where their stress is greatest, and following them toward the left, it is seen that those in the lower portion of the group sweep across the neutral axis everywhere at 45° and reach the lower boundary of the beam at right angles thereto and with stress reduced to zero. The upper portion or "sheaf" of this group sweeps across the plane of contraflexure at 45° and, inflecting, runs out to the lower left, forming the symmetrical counterpart to the figure in the upper right. The stresses in this sheaf reach a minimum somewhere in the vicinity of the plane of contraflexure.

The rise and fall of stress intensity as we pass along any trajectory is easily followed by noting the frequency with which the contours are crossed. To avoid confusion, the tension contours are omitted; they are the same as those for compression if reversed top for bottom.

The figures at the ends of the contours are proportional to the stress represented by each. To be exact, each figure will give the unit stress in lb. per sq.in. if it be multiplied by $\frac{3}{4}\frac{W}{h}$ where W is the total shear and h the semidepth of beam (the breadth of the beam is assumed unity in this and all that follows). The contours occur in pairs, the limbs of each pair being symmetrically located about point O. The "lay" of the contours is sufficiently plain for the high values, down to contour 1½. In passing from 1½ to 1 the curves (not drawn) point in sharply toward O, the limbs for contour 1 being FOH and EOJ, i.e., the neutral axis is a part of contour 1. In passing to values below 1 we should consider the limbs of contour 1 as FOJ and EOH, whence we pass through contour ½ to the two straight lines CD and AB, which constitute the zero contour. All these contours belong to a single family of curves representing a quartic equation which will be derived later (Fig. 6).

The trajectory forming the top of the right-hand part of the beam turns suddenly through 45° at C and proceeds downward toward the left. This feat would be impossible without rupture were it not for the fact that all stresses vanish at C. Point C is a *singular point*, about which there is no difficulty if we always view it in the light of the limiting position of the forms immediately around it.

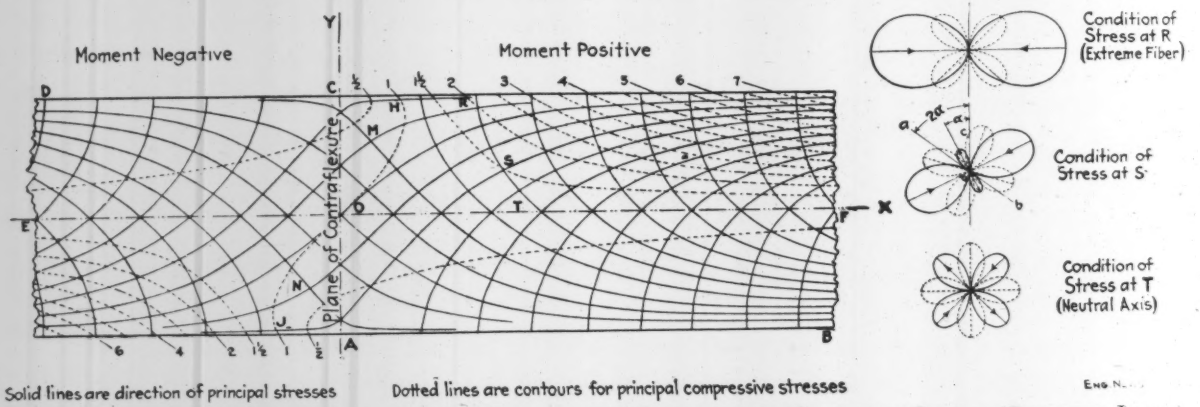

Moment Negative
Moment Positive
Plane of Contraflexure
Condition of Stress at R (Extreme Fiber)
Condition of Stress at S
Condition of Stress at T (Neutral Axis)
Solid lines are direction of principal stresses
Dotted lines are contours for principal compressive stresses

FIG. 5. STRESS TRAJECTORIES AND STRESS CONTOURS IN BEAM UNDER CONSTANT SHEAR (BETWEEN LOADS) NEAR PLANE OF CONTRAFLEXURE

It will be noticed that somewhere near M the compression trajectory there shown will be tangent to some contour (not drawn) between the values ½ and 1. Clearly, this is a point of minimum stress in that trajectory.

The locus of these points of minimum stress for all the trajectories is some curved line such as *CMONA* (not drawn), and it can be shown that this is also the locus of points of inflection in the tension trajectories—a truth that seems at least probable from the drawing of the figure, for since all the trajectories cross the X- and Y-axes at 45°, they must inflect between them.

Everything that we have been saying about the compression curves applies equally well to the tension curves, for the whole figure is symmetrical about the vertical as well as the horizontal axis.

For all points of a homogeneous beam not too near the points of support it is probable that the condition represented by Fig. 5 is very near the actual condition. Even if the assumption that horizontal stress is proportional to distance from the neutral axis were considerably in error, the general forms of the curves would still hold good, and especially would this be true of the trajectories.

The complete conditions of stress at the three points *R*, *S* and *T*, have been plotted in the three figures to the right of Fig. 5. The dotted four-leaf clovers representing shear are all of the same size, since the three points were so chosen, the shears being ± 1 for each point. From the contours, we see that the normal-stress intensities are 2 and 0, 1½ and −½, and 1 and −1. The inclination of the axes of all three diagrams conforms exactly with the trajectories for the points *R*, *S* and *T*.

At *R*, there is no *uncombined* shear, the stress there being purely linear.

At *S*, the shear *oc* is pure since the normal stress in the direction *oc* is zero, *oc* being tangent to the lobes of the normal-stress curve. Line *oc* is normal to the pure shearing plane in question, which is, therefore, horizontal. Notice in passing that the vertical direction is tangent to the lobes of the normal-stress curve for every point of the beam because one assumption upon which all our stress distribution is based is that the vertical normal stress is everywhere zero. (See Eq. 1 later on.) There is also a second plane of pure shear normal to *ab*, making an equal angle on the other side of the principal stress.

At *T*, the principal shears themselves are pure.

If we imagine the diagram for *T* to move along the neutral axis, it will remain always the same in position and size. If, arriving at *O*, it moves up to *C*, it will decrease in size to a point at *C*, but retaining the same shape. If we imagine the diagram for *R* to move along the top of the beam, it will vary in size according to its distance from *Y* but it will be geometrically similar in all positions and with axes in the same direction.

Every horizontal plane is a plane of pure shear, but the only vertical plane of pure shear is the plane of contraflexure. There is also a family of curved surfaces along which the shear is pure and these correspond to the other direction of zero normal stress, *ab* (in the diagram for point *S*). These surfaces will everywhere make double the angle with the horizontal that is made by the normal stress trajectories. This system, and the system of all horizontal planes, constitute two sets of surfaces of pure shear, which are everywhere mutually bisected by the normal-stress trajectories.

It is evident that the region of highest shear is the same as the region of highest normal stress, i.e., where the bending stresses are highest. In view of the fact that we always associate "dangerous" shearing stresses with the end portions and neutral axis of a beam, this may at first seem strange, but it will be noticed that these high shearing stresses are *combined* shear, that is, they occur on planes where there is also normal stress. In other words, they are the high shearing stresses that occur on every diagonal plane in ordinary direct stress, and the extreme-fiber stress is direct or linear stress. The ultimate shearing strength of concrete is about $\frac{1}{6}$ of its ultimate compressive strength; nevertheless, when a concrete strut is about to fail in compression it is developing a shear on the diagonal plane of one-half the direct compressive stress. But resistance to shear is assisted by normal compression just as resistance to sliding is assisted by pressure between the surfaces. In speaking of "resistance to shear," "shearing strength," or "planes of shear," only uncombined or pure shear is meant. Every time we test a piece to failure in tension we prove that its resistance to simple shear *cannot be less* than one-half its tensile strength. Every time we test a piece to failure in compression we prove nothing in regard to its resistance to simple shear.

No matter what the shape and loading of the structural form whose internal stresses we may wish to investigate, it is usually possible to "apprehend," without any computations, the general forms of the stress trajectories. On the other hand, a rigid analytical derivation is usually complex and tedious, if, indeed, it is possible. In the case of simple bending, however, the derivation is not so cumbersome, and we will briefly indicate how the curves of Fig. 5 were laid out.

With origin at *O*, the bending moment *M* at any section is *x* times the total shear, or *Wx*. The horizontal normal stress on this section at any height *y* above the neutral axis is,

$$P_x = \frac{My}{I}$$

Substituting Wx for the moment M, and $\frac{2}{3}h^3$ for the the moment of inertia I, we have

$$P_x = \tfrac{3}{2}\frac{W}{h^3}xy$$

The vertical stress for this type of loading is assumed zero, and the horizontal and vertical shears are given by the well known expression $q = \frac{W}{2I}(h^2 - y^2)$. Letting h, the semidepth of the beam, equal unity for simplicity, we collect the following three fundamental equations for normal stress and shear:

$$P_y = 0 \qquad (1)$$

$$P = \tfrac{3}{2} W x y \qquad (2)$$

$$q = \tfrac{3}{4} W(1 - y^2) \qquad (3)$$

which give completely the stress on the horizontal and vertical planes for any point (x, y). These planes cannot be the directions of principal stress, since the shears on them are not zero. To cover this case we have from the laws of variation of stress at a point (see equations 5 and 6 of first paper, ENGINEERING NEWS, March 12, 1914, p. 547.)

$$\tan 2\alpha = \frac{2q}{P_y - P_x}$$

$$P_1 \text{ or } P_2 = \tfrac{1}{2}(P_x + P_y) \pm \tfrac{1}{2}\sqrt{4q^2 + (P_x - P_y)^2}$$

where α is the slope of the principal stress measured

clockwise from Y, and P_1 and P_2 are the intensities of principal stress. Substituting in these equations for Px, Py and q, their values in terms of x and y as given by (1), (2) and (3):

$$tan\ 2\,a = \frac{y^2 - 1}{xy} \qquad (4)$$

$$P_1 \text{ or } P_2 = \tfrac{3}{4} W \left(xy \pm \sqrt{x^2y^2 + (1 - y^2)^2}\right) \qquad (5)$$

These are the final equations from which all the curves may be plotted, (4) for the trajectories and (5) for the contours.

To use equation (4), numerical values for x and y are assumed and the value of a computed therefrom is laid off as a slope at that point. When a sufficient number of such slopes have been drawn at various points, any trajectory may be drawn, not *through* the points, but to pass *among* them at slopes interpolated from the nearest indicated slopes. This gives quite as satisfactory results as if the curves were plotted in the usual way from cartesian coördinates. Note that any number of values differing by 90° will satisfy equation (4), which thus accounts for both sets of trajectories.*

If P_1 is made constant in Eq. (5), the equation in x and y represents the locus of all points having the same intensity of principal stress, i.e., a stress-contour. To plot the curves the constants should be lumped into one and the equation solved as an explicit function of one variable if possible, thus:

$$\tfrac{4}{3}\frac{P_1}{W} = a = xy \pm \sqrt{x^2y^2 + (1 - y^2)^2}$$

It is possible to solve this for x, giving:

$$x = \frac{a^2 - 1}{2\,a\,y} + \frac{y}{a} - \frac{y^3}{2\,a} \qquad (6)$$

in which a is the variable parameter. The equation being in explicit form, the curves are easily plotted by usual methods.

Notice that in this case of bending the principal stresses are everywhere of opposite sign, for in (5) the radical must always be greater than xy, which means that P_1 is minus if P_2 is plus and *vice versa*. The compression curves everywhere remain compression and the tension curves remain tension. An example where this is not the case is shown in Fig. 6, in which the trajectories are dotted where the stress in them is tension.

The assumption that $Py = 0$ is not strictly true for beams with distributed load, and the shorter the beam as compared with its depth, the more this assumption is in error. Fig. 6 shows a very short beam in which the trajectories are plotted accurately with full recognition of this vertical stress, which, along the upper part of the beam, exceeds the maximum horizontal stress.

The distribution of this vertical compression is a matter of considerable interest. Imagine a small vertical prism from top to bottom of the beam at the top of which the stress is w, the load per unit area. Since the vertical stress on the free bottom of the prism must be zero, the entire stress w must be absorbed between the top and bottom by the *difference of the shears* on its right and left faces, and its rate of absorption with respect to y must be equal to the rate of change of shear with respect to x:

$$\frac{dP_y}{dy} = \frac{dq}{dx} \qquad (7)$$

just as the increment of direct stress in a small horizontal prism is equal to the difference of the shears on its top and bottom:

$$\frac{dP_x}{dx} = \frac{dq}{dy} \qquad (8)$$

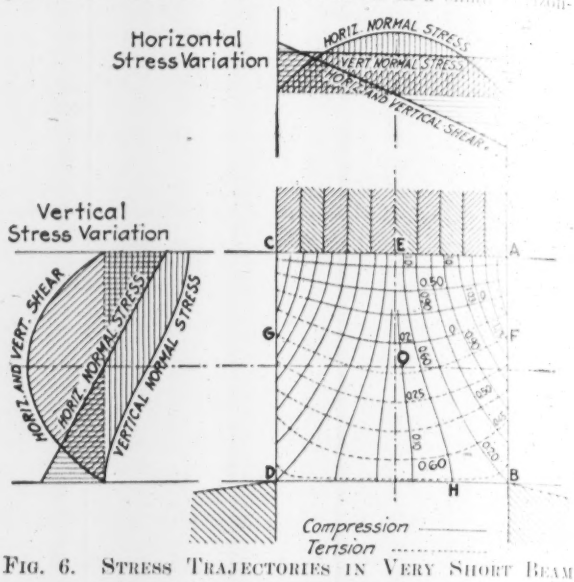


FIG. 6. STRESS TRAJECTORIES IN VERY SHORT BEAM UNIFORMLY LOADED

(Vertical compression due to load is taken account of.)

These are two very fundamental relations, the second one being used in all textbooks to get the well-known equation showing the parabolic vertical distribution of shear, already given in Eq. (3).

To illustrate the vertical distribution of normal stress with the case in hand, we assume the origin at the center of the beam. For uniformly distributed loading Eq. (3) becomes:

$$q = \tfrac{3}{4}\,wx\,(1 - y^2)$$

which shows the linear variation horizontally and the parabolic variation vertically. Differentiating with respect to x:

$$\frac{dq}{dx} = \tfrac{3}{4}\,w\,(1 - y^2)$$

Hence, by Eq. (7),

$$\frac{dP_y}{dy} = \tfrac{3}{4}\,w\,(1 - y^2)$$

or,

$$Py = \tfrac{3}{4}\,w \int (1 - y^2)\,dy = \frac{w}{4}(3\,y - y^3 + 2) \qquad (9)$$

the constant of integration being found by the condition that $Py = 0$ when $y = -1$.

The curve on the left of Fig. 6 shows graphically the manner in which this vertical normal stress falls off from top to bottom, the abscissas of this curve representing Py in the cubic equation (9).

Equation (9) takes the place of Eq. (1) in deriving expressions for Fig. 6 analogous to those already derived for Fig. 5, but beyond this point the equations become

*As a matter of fact, eq. (4) is the differential equation of the family of trajectories, its primitive being in the form $y = f(c, x)$, where c is the variable parameter of the family.

cumbersome, and, the general methods having been pointed out, we will carry them no further.

Our assumptions for this short deep beam would be very difficult to embody in an actual beam. For a beam of such proportions true beam action may be said to have ceased. Nevertheless, the trajectories must have substantially the forms which are here shown as the results of exact deductions from idealized assumptions. The vertical compression initiated by the load, as it passes downward must curve outward to reach the supports.

In longer beams we may have planes of reasonably pure shear, as at the positions of contraflexure, but we cannot make the beam fail by shear on such planes because the normal bending stresses not far to the right and left are so much greater. When the beam is very short, it has practically degenerated into a "punch," and the failure by shear along the lines *AB* and *CD* is progressive and becomes very complicated.

Unlike the case represented in Fig. 5, where the principal stresses are always of opposite sign, in the short beam the principal stresses are of the same sign throughout a large portion of the top. The bending stresses, which are compressive at the center section, pass through zero and become negative or tension before reaching the ends. The change occurs at some curved locus passing through *A*, *O* and *C*, as shown by the change from solid to dotted lines. The principal stress, which is vertical along *AC*, increases downward to a maximum along some curved locus *GEF*, below which it is decreasing everywhere. Also, the tension in the bottom reaches a minimum on some locus *bo*, which is also the locus on which the solid-line curves inflect.

Figures along the trajectories give actual stresses if multiplied by $\frac{3}{4}\ W/h$.

The stresses in a homogeneous beam are characterized by a perfect flow, or absence of abrupt change. Direction and magnitude are everywhere continuous functions of the coördinates of the point.

This may be said of all bodies, and, indeed, of stress in general. Even where so called external loads are applied, there can be no abrupt change in stress. Strictly concentrated loads may not exist, for then the stress intensity under them becomes infinite and failure (i.e., crushing) must occur until the load *is* distributed over some finite area. Angles and corners in stressed bodies are not consistent with a flow of stress, and nature abhors them as she does a vacuum (whatever that may mean). A very slight rounding is sometimes sufficient to prevent rupture, as, for instance, the fillets in castings. Wherever an angle is absolutely sharp, there incipient rupture must occur unless all stresses vanish at the point.

The effect of the load on the beam in Fig. 4 may be conceived as traveling along the trajectories to the abutments. The trajectories are conceived as intersecting fibers which constitute the whole of the beam, the stress in each being direct. Thus, the load is distributed along the arched backs of the compression fibers, and as it passes outward and downward it is gradually diminished or absorbed by the curved pull of the tension fibers, until it reduces to zero at the bottom of the beam and to a finite residuum at the end, which latter, in composition with an equal residuum from the tension fibers, is exactly equal to the end reaction or shear. As the stress flows outward and upward in the tension fibers, it is similarly reduced by the thrust of the compression fibers, the action of the two sets of fibers being mutual.

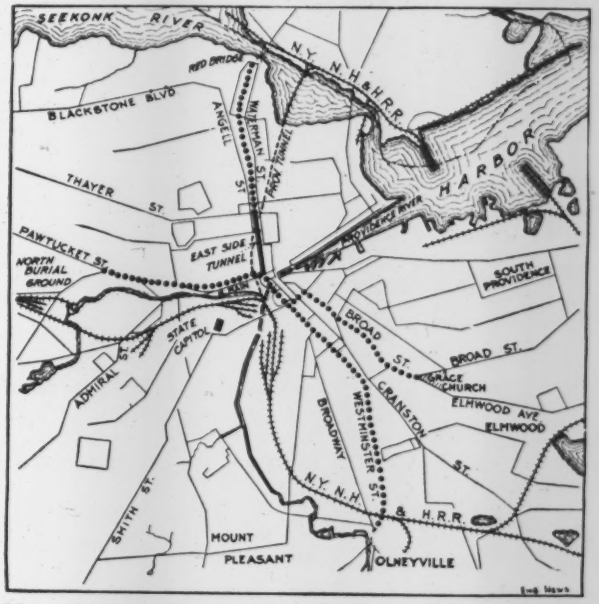
The Proposed Subway System for Providence, R. I.

A comprehensive scheme for the construction of rapid-transit subways, in Providence, R. I., has been recommended to the City Council by a special Committee on Subways (John W. Kelso, Chairman) as briefly noted in ENGINEERING NEWS, Mar. 12. The report contains the report of the committee's engineer, William W. Lewis (Assistant Engineer, Boston Transit Commission), and a bill to be introduced in the General Assembly of the State, to provide rapid transit in Providence.

ENGINEER'S REPORT

Mr. Lewis sums the result of his studies in five conclusions as follows:

(1) The traveling public and the business interests are entitled to better facilities than they now enjoy.



MAP SHOWING PROVIDENCE SURFACE CAR LINES AND PROPOSED SUBWAYS

(2) While the general business of the city would find considerable relief by widening any of its streets, the transportation facilities resulting would show very little betterment, and this betterment would last only for a few years.

(3) A system of subways properly designed for future extensions would give business the needed relief and would furnish the traveling public with an uptodate rapid-transit system.

(4) These subways would be a permanent construction and of sufficient capacity to carry several times the present traffic of the city.

(5) The city of Providence can afford to build these subways and the Rhode Island Co. (operator of the present surface-car system) can afford to lease them.

The present conditions have been admittedly unsatisfactory for many years on account of the very narrow streets and very steep grades with which Providence is afflicted, there being not only congestion of street-car traffic but of pedestrians on the sidewalks and vehicles in the roadways.*

*It should be noted that in 1911 Bion J. Arnold, of Chicago, made a report to the then Committee on Railroad Franchises of the City Council, on traction improvements and developments within the Providence district. He presented several recommendations in regard to the surface system. Briefly, he favored the enlarging of thoroughfares leading to the center of the city, a rerouting of the car lines in the terminal district, certain improvements in service and equipment, etc. He held, on the ground of investment required, that a subway system for Providence would not be justified until far in the future, and that ample relief from present evils could be secured by other means.

The population of the city is about 250,000, exclusive of the surrounding districts whose industrial and social existence is closely linked with that of Providence to form a metropolitan district with a population of about 425,000. The report shows that a little distance to the south the transportation lines converge so that a connection from each to a subway could be made near Trinity Square. Similarly, on the west the outlying territory would be drained through Olneyville Square; on the north near the North Burial grounds, and on the east near the "Red Bridge" over the Seekonk River (see accompanying sketch map).

The recommended subways take the form of a through north-south and an east-west line, meeting at a transfer station in the heart of the business district.

At each terminus, inclines or approaches would be built for surface cars entering and leaving. Way stations would be provided at points from 1300 to 3000 ft. apart, depending on density of population and local topography. These stations are planned as transfer points from the existing car routes which would be tributary. Although surface cars would be used at first, the tunnel would be designed to be adapted to the use of trains also.

The traffic records for the districts feeding into the southern line showed 33,800,000 passengers in 1913 (39.8% of traffic in the whole five-cent zone). According to these records in 1913 16,600,000 (19.6%) could have been carried through the western line from beyond the terminus. In 1913, the lines to the north carried 14,100,000 (17.6%). The lines east of Red Bridge, in 1913, carried 14,100,000 (16.7%). The traffic through the east-side line it is estimated can be increased by diversion from railroads, etc., to 16,700,000 on the 1913 basis. The surface-line passengers within the central district amounted to 5,400,000 in 1913 (6.3%), many of whom would enter a subway at way stations.

The cost of the east-west subway is estimated at $7,100,000 for the 3.5 miles. The north-south subway is estimated to cost $6,500,000 for the 2.4 miles.

The first piece of work recommended is the construction of an extension of the present East Side tunnel in an easterly direction. The second work recommended would be the south-side line running in from Trinity Square to Exchange Place, including the construction of the central transfer station. The first step noted is recommended as the logical completion of work already under way and the second is advocated because the traffic from the south is more than double that coming from any other direction, and because of the narrowness of the streets and inadequate service in this direction. The third and fourth steps would be the north and west lines, respectively. It is estimated that if the work on the east side extension were begun in 1914 it could be completed and equipped for operation by 1916. The south-side line could be finished by 1918, the north-side line in 1920, and the west side in 1923.

The report assumes that the cost of construction will be financed by the city with an issue of bonds outside the debt limit. On the completion of each line it would be leased to the operating company at a rental sufficient to pay interest on the bonds and contributions to a sinking fund for the retirement of the bonds. The report also discusses the ability of the Rhode Island Co. to pay these rentals and concludes that the company could safely undertake it.

Several comparisons are made in the report with the rapid-transit systems in other metropolitan districts. For instance, the estimated investment per capita on completion of these lines ($26.90) would be about one-half that required for the present Boston subway lines ($47.90), a little more than that for Philadelphia ($[illegible]), and about two-thirds that of New York ($67.75). Comparing the investment in capital stock and bonds of the Rhode Island Co.'s leased lines with the West End Street Ry. Co., of Boston, in 1894, when work on the first subway there began, it is reported that there is $[illegible],000 in the Rhode Island Co. compared with $24,[illegible],000 in the West End Co. The net operating revenue of the Rhode Island Co., in 1913, was $2,186,000 compared with $1,989,000 for the West End Co., in 1894. The gross receipts per capita in Boston, in 1894, were $7.80 compared with $10.70 in 1913, in Providence.

Recommended Legislation

The Act, which it is recommended the city solicitor shall make application to the General Assembly for passage, first establishes the Providence Transit Commission, consisting of the Mayor and Commissioner of Public Works ex-officio, and the seven members of the present Committee on Subways.

The Commission would choose its own chairman, appoint its own secretaries, and employ such engineers, surveyors, draftsmen, clerks and other employees as is found desirable.

The Commission is directed to proceed with the plans and construction of the subway lines already noted, including provision for carrying high- and low-tension wires, telephone and telegraph, cables, etc.

The Commission is authorized to execute contracts, approved by the City Council, for the use of the subways until July 1, 1932, and then to extend these agreements or to make new contracts for terms not exceeding 25 years. The rental would be fixed at 4% for the initial five years for each contract; 4¼% for the second five years, and 4½% for the remaining term.

⁂

The Development of Mineral Resources is aimed to be promoted by bills introduced into the Senate and House by Senator H. L. Myers, of Montana, and Representative Scott Ferris, of Oklahoma, as Chairman of the respective public-land committees. These are measures favored by the present administration to make available the coal, oil, phosphate and potash deposits of the Western States. In general, the bills provide for leasing the public lands under safeguards against monopolization and partial development.

Permits for the exploration of 2560 acres of oil lands will be issued, giving an exclusive right for two years, during which the work done must aggregate 2000 ft. depth. If oil is discovered, the permittee may receive a fourth of this area in fee, the rest remaining with the government—subject to royalty leases in small tracts. Drillings must be made more than 200 ft. from outer boundaries of lands leased or patented. Waste of oil and admission of water to oil strata are punishable by forfeiture.

Coal lands are to be sold, as at present, in small blocks but with provision for leasing—any holding not to exceed 2560 acres. To supply local needs, 10-year permits may be issued for up to ten-acre tracts. No person or association may have an interest in more than one lease. General regulations for leasing are to be made by the Secretary of the Interior. Royalties are to be based on production. A small rental per acre is imposed to prevent speculative holding.

Royalties from all these mineral developments are to go into the Reclamation Fund and to be used for irrigation projects in arid and semi-arid states. After being so used once, 50% of the royalties, upon their return to the Treasury, is to go to the proper state for schools and development.

Editorials

The two lunches and afternoon meetings of the New York section of the American Water Works Association held this winter have been eminently successful. The wonder grows why the water-works men of New York and vicinity waited a quarter of a century before adopting the practice which has been so fruitful of good fellowship and technical advancement among the water-works fraternity of New England. With Boston and New York as examples, we shall expect to hear of water-works lunches at stated intervals in Philadelphia, Chicago, St. Louis, New Orleans, San Francisco and Seattle and other cities. The natural outcome of such lunches would be the organization of sections of the American Water Works Association.

"Mechanical filtration come into its own at last," was the heart-felt remark of an engineer connected with one of the water-filter companies after George A. Johnson had presented his notable paper on water purification before the New York section of the American Water Works Association on Mar. 10. The paper was a strong argument for water filtration in general and mechanical filtration in particular, with some good words thrown in for hypochlorite disinfection.

Although for the time mechanical filtration seemed to be in full possession of the field, yet before the discussion closed Allen Hazen made some remarks which indicated that there is still something to be said for slow sand filtration beyond that it was a faithful old servant until displaced by a younger and more efficient one. Mr. Johnson's paper will give a good send off to the initial number of the *Quarterly* which the American Water Works Association is to start about Apr. 1. Meanwhile, some idea of his paper and the discussion which followed it can be gained from the brief article on the subject which appears elsewhere in this issue.

Secondary Stresses are Real

That the term *secondary stresses* is not an empty name, but denotes a real and definite tax on the strength of a structure, is the most important showing of the committee report summarized on p. 619 of this issue. We say most important, because a skeptical attitude concerning secondary stresses is very common among structural engineers, and this must be done away with before attention to secondary stresses can become a regular element of bridge practice.

Not only do secondary stresses exist, but measurements on bridges under load show that calculations of their amount come very close to the actual facts. This deduction from the American Railway Engineering Association committee's work becomes of vital importance as soon as engineers concede the necessity of dealing with these stresses. It will doubtless lead to frequent calculation of secondary stresses in the course of regular design, measurement of such stresses in old or doubtful bridges, and the recognition of the economy or lack of economy of particular types of construction, with regard to minimizing secondary stresses.

In the meantime, the committee's work is well begun, rather than completed. The work reported at present—which includes all the work carried out up to now, we believe—is not sufficient for all needs. The subject is too intricate and many-sided to be covered by a single set of tests.

An Object Lesson to Port Designers

Conditions surrounding piers and wharves carrying warehouses are peculiarly favorable to such fires as the one which last week destroyed nearly a million dollars' worth of property at Portland, Oregon, as noted in the news column of this issue. The accumulation of generally inflammable goods in such warehouses, and the large floor area on which these goods are stored make the start and continuance of a fire comparatively easy, and the very location of the wharves—open only to a marginal street and to the water—make fire-fighting extremely difficult. When added to these hardly insurmountable requirements, the structures themselves are of fire-increasing rather than fire-resisting construction, it is small wonder that the damage from these fairly frequent fires is so great.

It so happens that the Portland fire assumes special importance as an object lesson. About eighteen months ago, a Portland Commission investigating the question of municipal docks and warehouses received a report from a board of consulting engineers recommending an ambitious scheme of port development. Prominent among the recommendations was the insistence on fire-resisting structures and accompanying the report were designs of all the important works in reinforced concrete.

The Commission accepted the recommendations and set about to carry them out, at least in part; but after a number of months of continued effort, it decided that both public and official sentiment was against the fireproof construction, mainly on account of its high cost (with probably a mental reservation in favor of the local lumber industry) and that part of the scheme which was immediately started utilized timber construction. This work, which is now in progress across the river from the private docks where the fire took place, is of the best modern mill construction immensely superior to the buildings and wharves which burned, but it is nevertheless of timber, and subjected to the usual timber fire hazard.

It is to be hoped that the people of Portland will take the lesson of the fire to heart and recognize the final economy of fireproof construction in these mammoth port enterprises. Elsewhere on the Pacific Coast, notably San Francisco, local issues combined with the overwhelming ambition to present a finished modern port to

the first steamer through the Panama Canal, has led to the construction of the latest wharves and piers in wood. For these communities there is no need to repeat the time-worn arguments in favor of a permanent and fireproof structure. It may serve some useful purpose to point to that blackened five acres along the west bank of the Willamette.

The Government Railroad in Alaska

The bill for the construction of a government railroad in Alaska, which became a law by President Wilson's signature on Mar. 12, differs only in detail from the House bill reviewed in these columns in our issue of Mar. 5. The President is given entire and absolute authority over all matters in connection with the construction and operation of the road. He may "employ such officers, agents or agencies in his discretion as may be necessary to enable him to carry out the purposes of this act." He may, if he chooses, detail officers from the Engineer Corps of the Army or Navy to service in the construction or operation of the road. The sole limitations are that the entire road shall not exceed 1000 miles in extent and shall not cost more than $35,000,000; that if the road is leased for operation after completion, the lease shall not be for a longer period than twenty years; and that if existing railways in Alaska are purchased, the price paid shall not exceed the "physical value" of the railroad.

The foolish paragraph which we criticized in our issue of Mar. 5, providing that equipment and material belonging to any other government department could be drawn upon for the construction of this road has been stricken out. In its place there is a provision that any material or equipment no longer needed at Panama may be transferred to Alaska, the Isthmian Canal Commission receiving credit for such material or equipment transferred at such a percentage of the original cost as the President may approve. It is provided, however, that this equipment so transferred shall not be included in the $35,000,000 fixed for the cost of the road.

The principal usefulness of this clause is to illustrate the difficulty of getting out of the Congressmen's minds the idea that the machinery which has been used at Panama will be of great advantage in building the Alaska railroad, notwithstanding Colonel Goethal's explanation recently given that that machinery has been for the most part practically worn out by its long and severe service at Panama.

This is the first time in the history of the United States that the government has itself embarked in the work of railway construction. It is noteworthy that there has been substantially no public opposition and little public criticism of the proposal for government railway construction in Alaska. It has been generally recognized that under the peculiar conditions existing there, the only practical means by which the Alaska coal deposits can be opened and made available to the world is by having the government itself construct the transportation lines.

That the railway will prove a source of direct profit to the government—that is to say that it will return a fair rate of interest on the capital invested in it—seems very doubtful. The cost of Alaska railway construction and operation is bound to be excessive from the [illegible] prevailing rate of wages if for no other reason. [illegible] as can be judged at present, the only possibilities [illegible] profit-earning traffic are from the coal mines; [illegible] there should eventually develop a heavy traffic [illegible] sort, sufficient to enable the railway to earn a di[illegible] on its cost there would at once be agitation to redu[illegible] freight rates so as to enable the coal miners better [illegible] compete with their commercial rivals on the ground [illegible] the railway was built by the government not to earn [illegible] profits but to develop Alaska. On the whole, it will [illegible] generally agreed that if the experiment of government [illegible] way construction is to be tried, Alaska is as good a [illegible] as any in which to try it.

The Dayton City Manager on Commission-Manager Plan of Municipal Government

Sweeping innovations in American city government seem to have their origin or gain their impetus in the administrative weaknesses which are made evident by floods. Thus, the Commission plan originated in Galveston, in 1901, after the flood of the previous year, and similarly the City-Manager plan, already adopted by a few small cities and towns, suddenly came into nation-wide prominence when it was accepted as a fundamental modification of the Commission plan at Dayton, Ohio, after the floods of 1913.

Both the commission plan and the commission-manager plan have more than passing interest to engineers because the first tends to relegate the engineer far to the rear, and the second bids fair to more than bring him back to his former place as a recognized important factor in municipal administration.

Under the commission plan each of the five popularly elected commissioners, almost invariably laymen and often with little or no experience in city government, suddenly finds himself at the head of an important city department. Soon afterwards he regards himself qualified as an "expert" in half a dozen lines of municipal activity. He then begins to take unto himself, both within and without his own city, all the credit that is to be had for progress made in the various technical fields over which by the chance of popular vote he is a temporary ruler. In all this there is little likelihood that the engineer in the employ of the city will be working under conditions that make for efficiency or that will yield him credit for whatever good work he may be able to accomplish under difficulties.

Contrast with this the chances of the engineer under the city-manager plan. There he stands more than an equal chance with the men in any other profession or calling, of himself filling the office of city manager. If the engineer does not get that position, he has the considerable degree of consolation that comes from knowing that the city manager under whom he or his fellow-engineers do serve is likely to be a man selected for executive ability and not as a reward for party services or because of high ability as a vote getter.

How important the city manager appeared in the minds of the officials and citizens of Dayton, Ohio, after the commission-manager plan was adopted there last year and how determined they were to have an engineer of high standing and how willing they were to pay him for his

services, have all been given wide publicity by the offer of the position to Colonel Goethals at a princely salary, and the final securing for the position at no paltry compensation of Henry M. Waite, then city engineer of Cincinnati.

In view of this selection, great interest attaches to what is, so far as we know, Mr. Waite's first public address on the city-manager plan before an engineering body since he became city manager of Dayton.* We shall give below some extracts from the address, accompanied by a few words of comment.

Mr. Waite opened his address by asking the question, "Can local public utilities be operated as cheaply and efficiently by city government as by corporations"? In his opinion, the answer to this question depends "in no small measure upon the form of municipal government and its operation in practice." Dismissing as unworthy of consideration the sort of city administration which has as its chief object the finding of berths for "labor that has passed its zenith of usefulness in other fields," the speaker touched briefly upon the well known weaknesses of party government and the boss system, the most conspicuous result of which was that our cities were "operated by men who were not particularly trained for the positions" they were filling. The inevitable failure of this system led to a demand for a change which would give greater efficiency and economy in city government. Mr. Waite stated that "the first permanent step away from the old form of municipal government was the commission plan," under which men were either elected to carry out certain prescribed functions of government or distributed those functions among themselves after their election. This proved to be only a step toward reform, since like government by parties it still left the selection of executive officers, many of whom must be technically trained men if efficiency were to be secured, to the chances of popular vote. Or, as expressed briefly and forcibly by Mr. Waite:

> Again we were confronted by failure of the ballot to select the right men to take charge of particular functions of government that required training and experience for efficiency.

This is exactly what might have been expected and it seems strange indeed that such a system of municipal government should have suddenly come to the front and swept over the country just as it had become firmly established in the minds of persons who were giving thoughtful attention to the principles and practices of municipal government that one of the essentials to success is as complete as possible separation of the legislative or policy-determining functions and the executive functions of municipal government.

The next step in advance in city government, Mr. Waite stated, was the commission-manager form. Taking Dayton as an example, Mr. Waite said:

> In Dayton the organization is on the pyramidal form and is based on five as the ideal number. We have five commissioners as the legislative body who may employ the city manager; under the city manager there are five directors at the head of the five principal functions of government, namely, service, safety, welfare, finance and law. The heads of these five divisions are selected and appointed by the city manager. Here is the first and principal application of business method to city government. Under the old form we voted for the heads of the various departments. It would be just as reasonable to expect a corporation desiring to fill a particular vacancy in its organization, to go out and ask the neighborhood to vote on someone to fill that particular place.

Mr. Waite stated that in selecting heads of departments for Dayton, he made a careful study of the local situation and then, with one exception, chose men from material available in the city, basing his selection upon ability and experience. The exception was the Director of Service. For this position, Mr. Waite chose his principal assistant engineer in Cincinnati, "a man who has had experience in large construction work and municipal work." The director of service has charge of health, water-works, all enginering, contracts, maintenance of streets and sewers, the handling of garbage and ashes, and supervision of all public utilities."

As might be expected of Mr. Waite, it is impossible for him to tell the "political faith" of any of his appointees in Dayton, the only requisites being "efficiency, economy and loyalty." The plan of selection outlined by Mr. Waite may be characterized in his own words as consisting of "one man" at the head of a complete organization actuated by "one idea, efficiency." With such an organization actuated by such an idea and ideal, what may not be expected from the commission-manager plan at Dayton?

That Mr. Waite himself heartily believes in the commission-manager plan as the best scheme of municipal government thus far devised, may be expressed in his own words. He says:

> We believe we have the most business-like form of government yet proposed in this country—in fact it is the form of organization under which our private corporations have had such phenomenal success and we can accordingly see no reason why it will not prove the best form of city government under which to operate public utilities.

At the same time, Mr. Waite is living in no fool's paradise. His earlier experience in municipal work has naturally enough opened his eyes to some of the weaknesses in municipal government which thus far seem almost ineradicable. He refers in his paper to the necessity for a mass of red tape and a series of formal actions requiring long delays, all as safeguards against various dishonest practices and to give the people time to be informed and discuss propositions which are up for consideration, and which may, of course, involve the expenditure of large sums of the people's money.

He also mentions two other difficulties inherent for the present in municipal work. These he states, in concluding his paper, as follows:

> In all public work, we are confronted with the idea that is grounded in the minds of most men that they do not have to do as much work nor do they have to take as much interest as they do in individual or corporate concerns. Civil service likewise does not produce ideal results from an operating standpoint. But we believe that better results can be obtained under the commission-manager form than under the older forms, due to a more efficient method of selection and removal [of officials and other employees] by the application of our successful business methods to our municipal government.

The whole country will await with interest the results under the commissioner-manager plan at Dayton. That city is the only one of over 100,000 population which has yet adopted the city-manager plan. For that matter, the next to it in size, Springfield, Ohio, had a population of less than 50,000 in 1910.

Before dismissing this subject, we cannot refrain from touching upon a point not mentioned in Mr. Waite's address. That is, whether even those American cities which have progressed as far as the commission-manager plan

*Mr. Waite's subject was "The Effect of the Commission-Manager Form of Municipal Government on Publicly Operated Utilities." The addres was delivered on Feb. 26, 1914, before the Indiana State Sanitary and Water Supply Association at Indianapolis.

have yet got far enough away from past traditions and practices to keep any one city manager long enough in office to give either him or the plan a fair test. In all cities which have so far adopted the plan, the city manager is subject to instant removal by the city council. In Dayton, we regret to have to add, he is subject to recall by popular vote.

It is true that private corporations often keep their general managers for many years and that German cities retain their burgomasters for life or until they are called to larger cities. Both these facts, combined with the numerous instances of American cities retaining important executive officers for decades, give reason to hope that some, at least, of our cities will give an efficient city manager a long enough term of office to show what can be done under the plan when it is given a fair trial. In conclusion, we express the hope that Dayton will prove to be one such city; and we are sure that the engineering profession will join with us in hoping that Mr. Waite will be one of many engineers who, as city managers, are given not only time but every other opportunity to prove their fitness for this new new line of municipal work.

Letters to the Editor

Models in Engineering Design

Sir:—I was greatly interested in Wm. M. Torrance's letter (ENG. NEWS, Dec. 18, 1913) in regard to models in engineering design, as it touches a point involving important engineering principles which are persistently ignored.

Someone has said that there is nothing new under the sun; so, as Mr. Torrance suspects, there is nothing new in the ideas suggested in his communication, not even in the particular example he has chosen to illustrate them.

It may interest Mr. Torrance, and your readers at large, to know that as far back as 1899 Professor Archibald Barr, of Glasgow University, read a paper before the Institution of Engineers and Shipbuilders in Scotland on "Comparison of Similar Structures and Machines." In his paper, Professor Barr referred to a previous paper read before the same institution in 1875 by the late Professor James Thomson, whose fame in the scientific world has been overshadowed by that of his brother, the late Lord Kelvin. Professor Thomson's paper was on "Comparison of Similar Structures as to Elasticity, Strength and Stability."

Professor Barr sought to draw the attention of the members of the Institution to the "very important and far-reaching principles" brought forward by Thomson; and, besides developing those principles, he applied "a similar mode of reasoning to questions involving kinetic as well as static actions."

With characteristic lucidity of thought and clearness of expression, Professor Barr enunciated the following theorems which thoroughly cover the whole subject:

Two similar portions of matter will be alike severely stressed across all corresponding interfaces, when the forces to which they are subjected from without are applied over corresponding areas, and of like intensities and directions at corresponding places.

Similar structures are alike suitable to bear loads similarly disposed, and of the same intensity at corresponding places.

Similar structures are alike suitable to bear total loads proportional to the squares of their linear dimensions, applied in similar directions at corresponding places.

Two portions of matter which are similar in form and in substance when unstressed, will, when alike severely stressed, suffer similar deformations (or strains).

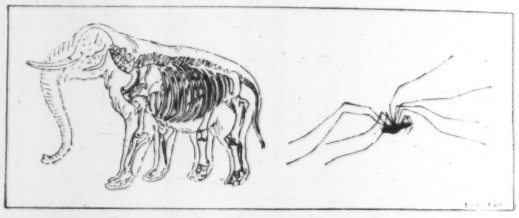
Test pieces having similar forms will give similar results if of like material.

The weights of similar structures increase, with increase of dimensions, in a higher ratio than the loads which the structures are alike suitable to bear.

Similar structures are capable, as regards stability, of withstanding wind pressures—or other distributed forces—similarly applied and of intensities proportional to their linear dimensions.

Similar engines (neglecting the small statical effects of their weights) are alike suitable to work at the same steam pressure and at the same piston speed, i.e., at numbers of revolutions per minute inversely as their dimensions. The powers will then be as the squares, whereas the weights will be as the cubes of the linear dimensions.

One of the examples chosen by Professor Barr to illustrate the theorems was that of two railway tanks of similar forms but one of them of double the linear dimensions of the other. He pointed out that in order to have the same unit stresses in the materials of both



COMPARISON OF STRUCTURAL CHARACTERISTICS OF AN ELEPHANT AND A SPIDER

tanks, the column supporting the larger one would need to have a thickness of metal (the columns in the example were hollow cylinders) not twice but *four* times that of the smaller tank. Also, the material forming the tanks themselves would have to be out of proportion in order to suffer the same unit stresses.

Nature, in the multitude of her structures, has carefully sidestepped the fallacy of designing similar structures by simply increasing the scale of the linear dimensions; and in the example of the elephant and the spider (see illustration), Professor Barr furnished the *reductio ad absurdum* of the faultiness of such a method of design. It will be seen that in the case of Phocus Phalangioides we have a very small body supported by very long and crooked legs placed entirely outside the body. It will be clear to anyone that a *similar* animal with a body the size of that of an elephant would be an absolute impossibility. Imagine such an animal weighing about 5 tons, with crooked legs 80 to 90 ft. long and 6 in. in diameter, walking on a web 600 to 700 ft. in diameter, made in meshes 30 ft. wide and of cords ½ in. in diameter! The thing is absurd, and as Nature knows it, when designing an elephant another plan is followed: the legs

are made much shorter (in comparison), considerably straighter, and are placed under the body.

In connection with test pieces, Professor Barr gave American engineers credit for being more scientific than their British colleagues. He said: "In America, sometimes at least, specifications now give the proportions, e.g., when the extension is specified for a specimen 'ten diameters in length.'"

Unfortunately, Professor Barr's words, as regards America, are still true. Only *sometimes* the proportions of the test piece are given. For instance: the specifications of the American Society for Testing Materials for steel for buildings call for a certain elongation on a standard test piece; but the same specifications allow the substitution of a piece turned to ¾-in. diameter. Seemingly the Society expects the same result from a bar ¾ in. in diameter as they would expect from one ¾ in. thick by 1½ in. wide, which is the width of the standard specimen. Yet one sectional area is more than twice the size of the other. Again, in the specifications for reinforcing bars, the same results are expected from square and round bars. And the same unscientific methods prevail in specifying bending tests.

Specifications call for different bars to be bent flat or through different angles around different diameters. With some allowances for differences in manufacture, bars of the same quality should be bent through the same angle around pins of a diameter proportional to the diameter of the bar in order that the bars should give the same results.

It will be seen, therefore, that the principles involved in similar structures are of great practical importance and that they should be thoroughly understood by designers, especially so called practical men who in designing the members of a structure, trust too implicitly to their eyes.

I think Mr. Torrance ought to be congratulated for having brought this matter of similar structures to the attention of your readers.

M. J. LORENTE.

Lockwood, Greene & Co., Boston, Mass.,
Feb. 2, 1914.

An Early Instance of Cement Grouting of a Dam Foundation

Sir—In his article on "The Injection of Cement Grout into Water-Bearing Fissures," in your issue of Feb. 5, 1914, p. 321, Francis Donaldson states that this process was attempted for the first time in this country at Shaft 4 of the Catskill Aqueduct.

Although no account of it has been published, the process had been previously used in the construction of a small concrete dam for the water-supply of the village of Fort Plain, N. Y., where two open seams of considerable depth were encountered in the rock at the north end of the dam. These seams dipped about 30° in the direction of the flow of the stream and appeared on the rock face both above and below the dam site.

In order to avoid a large amount of rock excavation, these seams were closed by first calking them several inches deep with oakum and tar for some distance above and below the dam site and then forcing neat cement grout behind this calking by means of a force pump in such a manner as to drive the water, etc., out of the upper end of the seam ahead of the grout.

After the filling of the reservoir a careful observation showed no leakage through these seams.

The work was done under the direction of J. W. Jenkins, Chief Engineer, with whom the idea originated, during the summer of 1902, at least six years prior to the grouting of Shaft No. 4.

J. E. JENKINS.

Southern Pines, N. C., Mar. 4, 1914.

The Report of the Am. Soc. C. E. Committee on the Compensation of Engineers

Sir—The writer wishes to express his sincere thanks to the Special Committee of the American Society of Civil Engineers appointed to investigate the condition of and compensation of civil engineers throughout the country, and only regrets that the exceedingly valuable effort of the worthy members of the committee did not meet with consideration commensurable with the importance of the subject: only 50% replied! At the annual meeting, on Jan. 21, the entire report was dismissed with a single sentence that the average curve of compensation is rather too optimistic, and the minimum looks so bad that further investigation would be necessary.

Indeed, the graph showing the compensation of civil engineers throughout the country (ENGINEERING NEWS, Jan. 22, p. 166) possesses wonderful properties. It proves authoritatively that a civil engineer, working or not working, receives a general average yearly compensation of $4325 and no worry, that he may hope after 18 years of experience to attain the royal income of $150,000 a year, that his salary will never be below $720 a year beginning with the first year's experience, that by entering on his professional career he has nothing to lose and everything to win, although, what a mockery of fate! How often have I seen on our Engineering Building at the College a profanely painted sign: "All hope abandon ye who enter here!"

It is much to be regretted that the members of the American Society of Civil Engineers did not fully comply with the request of the Committee. Why did they keep silent?

Is it because the engineer, satisfied with the general average yearly compensation of $4325 allotted to him by the committee, hid himself behind the blueprints, and took no cognizance of the fact that there was a world behind the office walls, that there was a butcher, and a grocer, and a doctor, etc.; and the great achievements of the glorious profession smiled to him through figures that became a part of his life dreams and contemplations?

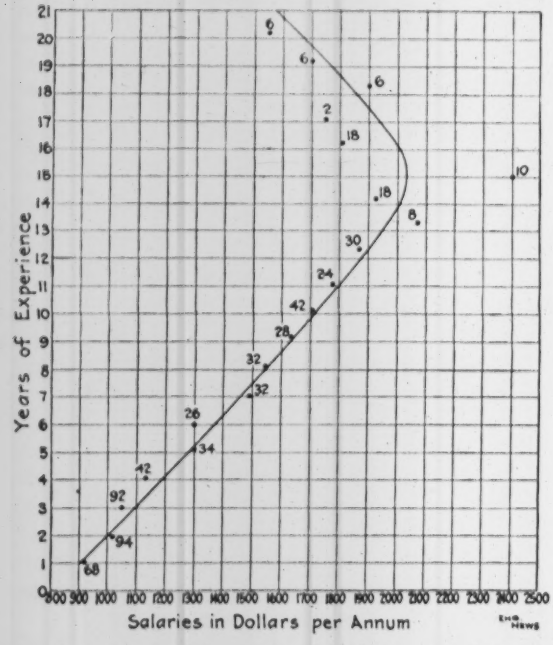
Is it because the engineer, thoroughly disgusted with his daily struggle for bread and butter, did not want to have insult added to injury, and drag into light his dark disappointments when after long years of training and experience he began to realize that his life was drifting toward a vanishing point?

A wonderful lot of men! They have defined engineering as an art of making the most for a dollar, and they are surely living up to the definition!

Referring to the chart accompanying the report of the committee, the writer wishes to state with apologies and

full appreciation of the work done that in his opinion it is "Love's Labor Lost." He entirely disagrees with the belief that the membership of the Society is large enough to be representative, and typical of various stages of engineering life, and that "the average curve errs if anything in being slightly too low."

Surprised at the result attained by the committee, the writer started on a tour around the town looking for a man with the average income for purely professional services. He did find men making $150,000 a year, but they were making it ON professional engineers, not AS pro-



fessional engineers. Disappointed in his search for a man getting the average salary, the writer turned to the dictionary to find the meaning of average, and there solved the mystery. On p. 385, last edition of the "Eclectic Dictionary of the English Language," "average" is defined as "portion of work done by animals of burden," and further, "the duty which the tenant is bound to pay to the king." Does the average curve represent the unpaid equivalent of engineering work which is retained by the employer as duty? If that is the case, the writer would accept the curve as it stands!

The writer personally canvassed over five hundred engineers in a locality where the salaries are considered high, among engineering organizations engaged in works estimated in tens of millions of dollars, where men were carefully selected, their qualifications as to training, experience and education investigated, certified and approved. It included men of highest type of engineering skill, with grave responsibilities.

A member of the profession who assisted the writer in compiling the data as to compensation of engineers has cynically remarked:

> Why did not the members of the committee look into the payrolls within their reach, where technical graduates with some ten years' experience are working at the very munificent salary of $1500 per year while the job lasts? Is it because, as Ernest McCullough in his book on "Engineering as Vocation," puts it: "It is hard to admit, but it is true that the men who pay the poorest wages, or salaries, to young men are the engineers with big reputations whose charges for their services are exceedingly high."

The writer plotted the results of his inve[illegible] because of his belief that the average curve of [illegible] Committee was entirely erroneous and misleading, [illegible] published would result in considerable injury to [illegible] young ambitious aspirant for the laurels of the engin[illegible] profession.

He does not question the sincerity of the [illegible] committee, for whom he has the highest respect, but the [illegible] engineer seeking information as to his future prospe[illegible] ought to be met with the truthful and sincere word[illegible] Prof. Carmichael, who, referring to mathematical and [illegible] demonstrations, said:

> It is hard, it is no child's play, it is the work of [illegible] and strong purpose. The material rewards are few, probably not many of your generation will appreciate your labors, and many of you will not be heard of after your day. But you will leave mankind a heritage of profit forever. You will hasten the day when all men will know that their chief benefactors are those who delve into the secrets of nature and reveal them to their fellows. Does that work appeal to you?

An engineer is primarily a scientist. He must be thoroughly familiar with the fundamental properties of forces and materials of construction. The day of college graduation is truly the commencement of his professional training. He must constantly refer to books and periodicals, and keep abreast with the rapid progress of present engineering; when his working hours are over, his hours of study begin, and for all that, his office hours are as long as the day of the unskilled laborer, and his compensation does not favorably compare with that of a bricklayer or a riveter.

In presenting his average curve, the writer does not claim that it illustrates the status of civil engineers all through the country, but merely shows the deplorable condition prevailing among the deserving members. It agrees with the opinion of numerous experienced men whom the writer interviewed on the subject. The figures were obtained through a secret canvass where the man was sure that his identity could not be disclosed, and they were individually approached only with a view of making them realize the necessity of having correct data for an unbiased opinion.

The curve does not say anything of the struggle for the first job, of the uncertainty of the position after one is obtained, and of the difficulties of securing one after the age of 50; to the young men, however, who wisely pause on the threshhold before entering the profession of civil engineering, it eloquently says, "BEWARE!"

In conclusion, I would ask the members of the Society to plead with the committee, that they should proceed with the good work they have begun, in order to prepare a more extensive and more conclusive report for the next annual meeting. They should adopt methods that would include the greater majority of engineers all over the country without confining themselves to the elite of the profession—to the members of the American Society of Civil Engineers.

GEORGE M. PURVER,
Assoc. M. Am. Soc. C. E.
146 E. 8th St., Brooklyn, N. Y., Jan. 29, 1914.

[The committee report to which our correspondent refers is discussed in the February *Proceedings* of the Am. Soc. C. E., by Edgar Marburg, P. A. Beatty, H. E. Phelps, Ernest McCullough, M. J. Herrock and Leonard Lundgren. All these engineers agree with the views expressed in our editorial of Jan. 22, and the comments of various correspondents in subsequent issues. Several

proof that the one or two $150,000 incomes included in the totals have a material influence in raising the general average. All the correspondents also emphasize that the average salary given ($4325) is the average of the highest paid half of a society, whose membership in general includes only engineers who have been more than ordinarily successful.—ED.]

NOTES AND QUERIES

The steel grain tanks whose failure was described in "Engineering News," Mar. 5, 1914, p. 538, were located at Dallas, Texas, and not at Austin, as stated there.

Annual Meeting of the Illinois Water Supply Association

The sixth annual meeting was held at the University of Illinois, Champaign, Ill., Mar. 9 to 11, with a large attendance. An important matter in relation to the future of the society was a proposition to affiliate with the American Water Works Association. A committee appointed to consider this subject reported in favor of such action, and it was decided to submit it to a letter ballot of the entire membership. If this is carried, the present organization will become the Illinois section of the larger association.

There were five business sessions, besides excursions to the laboratories of the University, the new water-treatment plant of the Urbana & Champaign Water Co. (for the removal of iron), and the sewage-treatment plant now under construction at Decatur, Ill. The annual dinner was given at the Beardsley Hotel, and was followed by several addresses by members and guests, including Mr. White (supervising architect of the University) who described the proposed plans for material enlargement of the institution.

The officers for 1914 are as follows: President, H. M. Ely, superintendent, Interstate Water Co., Danville, Ill.; Vice-Presidents, W. J. Spaulding (Springfield), E. Mac Donald (Lincoln) and W. De Berard (Chicago); Secretary and Treasurer, Edward Bartow, director, State Water Survey, Urbana.

There was a good list of papers. Most of them were short, and nearly all of these were followed by some discussion, while the discussion fell off when the longer papers were presented.

WATER-WORKS PLANT AND EQUIPMENT—A paper by W. Reid (superintendent of water-works, at Springfield) gave particulars of the test of a new 10,000,000-gal. vertical triple-expansion, crank-and-flywheel pumping engine. The duty (which exceeded the guarantee) was 171,830,000 ft.-lb. per 1000 lb. of dry steam at normal capacity and pressure (277 ft. head), developing 459.6 i.hp.; 169,256,000 ft.-lb. at 75% of capacity, and 162,810,000 ft.-lb. at 50% of capacity. The coal consumption was 1 lb. per 200 gal. pumped, against 131 gal. for the old triple-expansion 8,000,000 gal. engine, and 87.7 gal. for the old compound engine of 4,000,000 gal. A paper by J. M. Bryant (assistant professor of electrical engineering) dealt with the features and advantages of pumping city water by electricity. A formula for determining the economic size of stand-pipes (giving the cost and the weight of metal) was presented by H. E. Babbitt (Univ. of Ill.). C. M. Ross (Cairo, Ill.) described the failure of the Cairo standpipe.*

A method of locating leaks in mains by means of a water-hammer diagram was described by M. L. Enger (Univ. of Ill.); and L. Z. Jones (city engineer of Galva) described a method of locating leaks in deep wells by lowering electric lights and sighting with a glass.

Anchor-ice troubles at water intakes were dealt with by W. J. Allen, of Waukegan (who referred to the emergency intake described in ENGINEERING NEWS, Feb. 26, 1914) and by L. A. Fritze, of Moline. At Moline, the blower used in washing the filters is connected by a 2½-in. pipe to the shore end of a 20-in. gravity intake 3500 ft. long, and a pressure of 10 lb. never fails to clear the pipe.

The relation of the sewer outlet and water intake at Quincy was described in a paper by W. R. Gelston (Quincy) and Edward Bartow, director of the State Water Survey. A paper by F. E. Herdman (Waukegan) dealt with "Rates and Their Relation to Meters," and Mr. Tufts (Centralia Water Co.) outlined the history of the water-supply system at Centralia.

WATER-SUPPLY AND SANITATION—The public control of water-supply in Illinois by various state and local authorities was reviewed by John A. Fairlie, professor of political science, University of Illinois. Mr. Jackson (Lake Forest) described the proposed North Shore Sanitary District, to prevent pollution along the lake shore north of Chicago, and a resolution was passed approving of the establishment of such a district. A sanitary survey of White River, Ind., was described by J. Craven (Indianapolis). Dr. W. H. Frost (U. S. Public Health Service) described the sanitary survey of the Ohio River.

The surface water-supplies of Illinois were dealt with in a paper by Paul Hansen and R. Hilscher of the State Water Survey and the character of artesian well waters at Chicago was the subject of a paper by C. B. Anderson, also of the State Water Survey. The underground movement of contamination was considered in a paper sent by Dr. Gehrmann (Chicago). An illustrated talk on the Ohio River floods was given by John W. Alvord (Chicago). The death of the colon and typhoid bacilli in pure water was discussed in a paper by M. E. Hinds and Dr. Rahn (Univ. of Ill.).

WATER TREATMENT—The new filter plants at St. Louis, Mo., Evanston, Ill., and Flint, Mich., were described in illustrated papers by Mr. Wall (water commissioner of St. Louis), Mr. Pearse (Sanitary District of Chicago) and Mr. Buzzell (Flint). The St. Louis plant was described in ENGINEEGING NEWS, Oct. 23 and Dec. 25, 1913.

A paper by Dr. Worthen (Charleston, S. C.) described a remodeled underdrain system for a mechanical filter plant, and Prof. Talbot (Univ. of Ill.) described the iron removal plant of the Urbana & Champaign Water Co. A review of the introduction of the hypochlorite treatment was given by C. A. Jennings (Union Stock Yards, Chicago), who stated that it had been universally successful where applied properly and under proper conditions. Its main function is to deal with organisms which cause intestinal diseases. Mr. Bardwell (Chemist of the Missouri Pacific Ry.) discussed water treatment for railways, which consists mainly in the softening of waters that are too high in scale-producing elements to be satisfactory for boiler water.

*"Engineering News," Apr. 24, 1913.

Valuation for Rate Making: Discussion of Committee Report by American Society of Civil Engineers

A meeting for the discussion of the preliminary report of the Valuation Committee of the American Society of Civil Engineers was held at the house of the Society in New York City, on Mar. 11. The greatest possible interest in the report was displayed, the meeting room being crowded. The speakers (except the Chairman of the Valuation Committee) were limited to ten minutes and even after nearly three hours, "the crackle of fresh manuscript was heard all over the hall" as Prof. D. C. Jackson remarked in asking for adjournment to such date as the Directors could arrange.

The "Special Committee to Formulate Principles and Methods for the Valuation of Railroad Property and Other Public Utilities" is composed of F. P. Stearns (Chairman), Leonard Metcalf (Secretary), and Jonathan P. Snow, all of Boston, Alfred Noble, of New York, T. H. Johnson, of Pittsburgh, and Prof. W. G. Raymond, of Iowa City. The preliminary report which was presented without discussion at the annual meeting of the Society, on Jan. 21, has attracted wide attention, but the section on depreciation has not been generally appreciated so that the Chairman has issued a supplementary and more elementary discussion of this part. The main report (the general conclusions of which were presented in ENGINEERING NEWS, Jan. 29, and the section of which on depreciation was explained and abstracted in our issue of Feb. 12, 1914) was not read.

Mr Stearns in opening the meeting explained that the Committee had not confined itself to railroad valuation because some elementary ideas, particularly depreciation, could better be thus presented. His discussion of the committee's attitude on depreciation centered in three paragraphs.

> If a public-service commission is fixing the rates of a public utility, it must, in order to do justice, adopt some system of providing for earnings for depreciation. The system which it adopts should determine the question whether the property shall be valued as if new or at its depreciated value.
>
> (a) If the system adopted provides for the repayment in installments during the life of each item of property of the full value of such item, so that the capital invested in it will be entirely repaid when it goes out of use, that item of property during its life should at any given time be given a value less than the value new by the amount of the repayment of capital at such time.
>
> (b) If the system adopted provides for the repayment of capital in a lump sum at the time when the item of property goes out of use, or if it provides for the repayment in installments of sums much too small to aggregate at the end of its life the full amount of capital invested in the item of property, so that the installments must be placed at interest in a sinking fund, or elsewhere, in order to obtain the full cost of the item when it goes out of use, then the item of property should be valued throughout its life as if new.

To explain in detail these views, tables were offered showing, among other things for a hypothetical simplified case, "plant paid for with capital," "plant paid for from earnings for depreciation," "total value of plant new," and "total value of depreciated plant" for each year up to 12 years and for the four available methods of figuring depreciations: (1) renewal; (2) straight-line; (3) sinking fund; and (4) equal-annual-payment—which is the committee's favored modification of the straight-line scheme. (See ENGINEERING NEWS, Feb. 12, 1914.)

The discussion following was largely hostile to the committee. Dr. A. C. Humphreys (Humphreys and Miller, New York City; President, Stevens Institute of Technology) led off by suggesting that not one but many evenings should be set aside for the discussion and that final action should be delayed until the last word had been said. He was impressed by the practical quality of certain parts of the discussion of "overhead charges" but also with an excessively impractical quality of other parts, particularly that on "depreciation." He believed that in spite of the committee's carefully stated limitations, such as noted above in Mr. Stearn's presentation, their description of methods which called for depreciated value of plant as the basis of fair return would be isolated from the rest of the report and used as an argument for use of depreciated value under all conditions. He believed that similarly the committee's use of 5% rate in computing its tabular statements of depreciation and interest would be construed as an admission that such a rate was not too high in the one case and too low in the other. He was not disposed to agree with the commission's respect for "highest court decisions"; they must be heeded but they need not be accepted as final. He argued that whenever by reason of professional experience, engineers are qualified to instruct courts, patient, persistent and frank efforts should replace submission to error.

Dr. Humphreys in taking up the main bone of contention, the treatment of depreciation, defined "depreciation" as covering only the cost of renewal of plant which has to be replaced on account of decay, wear and tear, obsolescence or inadequacy; and he believed that there would be less misunderstanding if the term "deferred renewals" or "periodic renewals" were substituted. He defended the sinking-fund method with the argument that as the renewal of each item had to be made at the end of some term, then there was need of the actual payment therefor only at that time. The advance payments against renewals, however, should be distributed over rates for the expected life, for stability of assets and approximately correct idea of true profit and loss. While these annual advances against periodic renewals were seldom put into an outside sinking fund, yet computation on that basis offered a theoretical basis for the proper amounts. He criticized the "equal-annual-payment" scheme of the committee because, for equal-annual payments, equal rates of interest and depreciation were used to start with. The actual amounts set aside for depreciation by this scheme were over 150% more in the 20th year of an item's life than in the first, while he found no such increase in fact—neglecting contingencies which should be provided for in excess of mere depreciation. As the real net effect of using either the familiar sinking-fund basis or the committee's scheme were the same, he held that the latter was but a manipulation of figures requiring an added burden of bookkeeping.

F. Lavis (Consulting Engineer, New York City) maintained that railway-valuation should not have been neglected by the Committee and he asked that three railway men be added. H. C. Phillips (Valuation Engineer, A. T. & S. F. Ry., Chicago) also noted an inconsistency between the Committee's title and the substance of its report. He urged that no part of it be accepted as applying to railways, his argument being that the discussion related to a protected monopoly and

not, even in railroad work, where there was competition from one end to another.

A. G. Nicholayson (N. J. Board of Assessors, Trenton) applied the Committee's theories to the case of ten ferryboats operated by a transportation company, showing that if full return on capital and for depreciation be made each year, then when one boat was replaced out of the year's earnings, the capital return reduced to that on depreciated value. He favored the general idea of using depreciated values.

W. W. Crehore (Consulting Engineer, New York City) argued for a single valuation for all purposes—rate making, taxation, condemnation, or sale. He startled the members by urging that instead of laboriously determining a reproduction cost or other similar value for property, the value placed on it by the owners should be accepted on the basis of rates and taxation; he held that any tendency toward inflated value for higher rates would be prevented by the necessity of higher taxes.

P. W. Henry (Consulting Engineer, New York City) questioned the section on depreciation especially as to its use for railway work. Here there were so many items and these of such short life that the burden of the bookkeeping would become too great. He favored the straight-line method as best adapted to this field.

Morris Knowles (Consulting Engineer, Pittsburgh) believed that the methods of valuation for taxation were apt to change with changes in various state laws. He thought there was some time likely to be but one figure of value for all purposes. He cited figures for the engineering and contingencies of the design and construction of the Pittsburgh Water Works—4% for the machinery and 13% for concrete work which involved many details.

M. R. Maltbie (Member, Public Service Commission, First District of New York) was the only man present who commended the report without detailed criticism of parts. He was surprised after listening to the discussion that any six members could be found for such a committee who would agree among themselves on the questions involved. In his opinion the Committee had made a great contribution in emphasizing the impossibility of separating the basis of rates and treatment of depreciation—among the several matters which could not be dealt with independently.

Henry Floy (Consulting Engineer, New York City) first called attention to the fallacy in Mr. Crehore's proposition by reminding the members that taxes are paid by the customers along with operating expenses. He seconded Mr. Lavis' suggestion that the committee be enlarged, but he would have the three railroad men, also specialists in appraisals, instead of merely construction or operating engineers. He further suggested the addition of one attorney versed in those decisions of courts and commissions bearing on such matters.

He would accept most of the report and recommendations if applying to future concerns, but he did not think the recommendations could be followed for appraisal of old properties. He doubted if any commission could induce capital to invest under what he called "the Committee's tango treatment of return—a dip at each successive step." The committee was criticized for accepting, "as the only true gospel," the decision of the U. S. Supreme Court in the Knoxville water case, which he held had not been well prepared or presented. The points were emphasized that every court's decision was based on the peculiar circumstances of each case so that no single case was basis for generalization, and that no question was finally settled until settled equitably.

As an example of an open matter, in spite of a Supreme Court decision, he cited the denial of excess cost of railway land over market value in the Minnesota Rate Case as contrary to common knowledge and experience. The committee was asked to explain further by citations of decisions how its idea of "a repayment from the rate payer to the corporation of a part of its investment" was in accord with the views of the highest courts. He interpreted the decision of the Supreme Court in the Consolidated Gas and Knoxville Water Cases to mean that the basis of rates was the worth of plant based on its ability for service with needed repairs deducted.

The decision in the Minnesota Rate Case was cited to show that speculative cases, hypothetical conclusions and artificial values would not be accepted in place of examination of fact and positive testimony; the depreciation scheme of the committee, being held speculative, hypothetical and artificial, he did not think could be offered in court. Mr. Floy advocated strict consistency in use of reproduction-new values as dispensing equal justice on all old properties, instead of mixing reproduction of existing plant with historical conditions in an attempt, like the Committee's, to secure a still fairer value.

The report is to be further discussed at a supplementary meeting in the House of the Society, 220 W. 57th St., New York City, on April 2, at 2:30 p.m.. If necessary, the discussions will be carried over into the evening.

2400-Volt Overhead Construction of the Butte, Anaconda & Pacific Ry.*

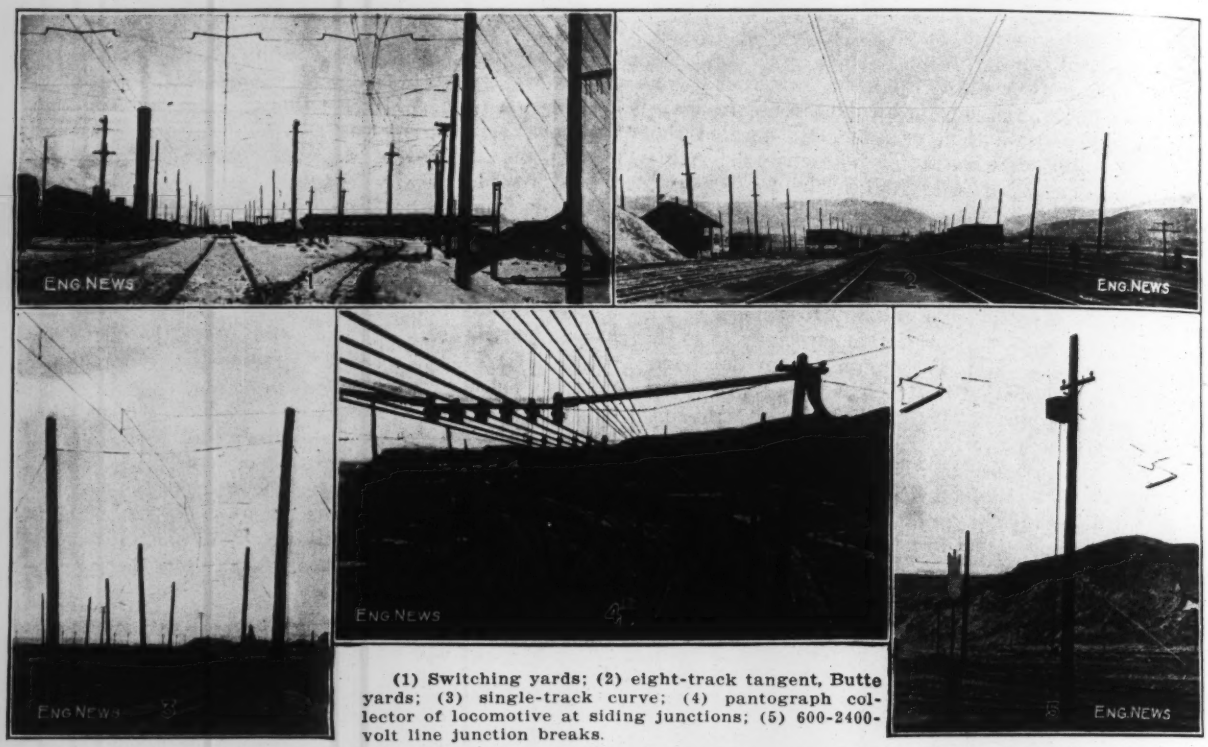
The construction and operation of the Butte, Anaconda & Pacific Ry., in Montana, has held unusually sustained interest as it is the first attempt to employ such high-voltage direct current, where steam locomotives have been used, and because the change in traction systems was made for both passenger and freight service from reasons of economy; moreover, for some 16 miles the road parallels the Chicago, Milwaukee & St. Paul Ry., which here is part of a mountain division which will be electrified by the use of a similar 2400-volt direct-current system (see ENGINEERING NEWS, Jan. 16 and Dec. 25, 1913, Feb. 12, 1914, p. 371). The plans for the use of direct-current at 2400 volts on the Butte, Anaconda & Pacific Ry., were noted in ENGINEERING NEWS, Aug. 15, 1912, and the locomotives were described as built, June 26, 1913.

The Butte, Anaconda & Pacific Ry. is essentially an ore line, carrying over 5,000,000 tons per year. Trains of 30 ore cars (68 tons weight loaded) are made up at the copper mines near the top of Butte Hill and lowered by two locomotives 4½ miles to the Rocker Yards west of Butte; here new main line trains are made up for the trip to the smelters at Anaconda. At East Anaconda, these trains are broken up and hauled up Smelter Hill to the stock bins. Shifting cars for weighing, etc., is done by single locomotives. The eastbound mine traffic comprises empty cars for Butte Hill and copper ingots for transshipment at Butte. There is also much local freight

*From information furnished by the General Electric Co., Schenectady, N. Y.

and passenger traffic between Butte (population 65,000) and Anaconda (population 10,000). The eight passenger trains per day over the line have a single locomotive and three to five cars. These trains were hauled by electricity first on Oct. 1, 1913 (ore trains were so hauled on May 28) and are reported to have made better time since than previously under steam operation.

a large amount of special work on account of [illegible] many yards and sidings, and in one case twelve [illegible] are spanned. The cross-span construction used at [illegible] point is supported by a third pole between the eighth and ninth tracks. The hanger used on the straight-line [illegible] truction is a rolled-steel strap, looped over the [illegible] ger wire. This loop is closed at the car and the [illegible] re is



(1) Switching yards; (2) eight-track tangent, Butte yards; (3) single-track curve; (4) pantograph collector of locomotive at siding junctions; (5) 600-2400-volt line junction breaks.

FIGS. 1-5. 1200-VOLT OVERHEAD CONSTRUCTION, BUTTE, ANACONDA & PACIFIC RY.

The maximum curvature of the road is 20° on the Butte Hill line; here the average is 6° to 10° also. The locomotives will take a 31° curve at slow speed. While the line is about 32 miles long, the sidings, yards and smelter tracks, which have been equipped with overhead wire, makes a total of about 95 miles of single track. As has been variously noted in ENGINEERING NEWS, energy is purchased from the Great Falls Power Co. There is a large station on the Missouri River, 130 miles away, from which energy is transmitted over duplicate lines at 102,000 volts. Besides, there are several 60,000-volt lines from other plants terminating at Butte. For transformation to railway current, two 1000-kw. converter sets were placed in each of two existing general-power substations. Each converter comprises a synchronous motor driving two 1200-volt generators electrically connected in series.

OVERHEAD CONSTRUCTION

The overhead construction for this system was especially designed to give the flexibility necessary for satisfactory operation of the roller pantograph collectors used on the locomotives. The No. 0000 grooved-copper trolley used over all tracks is supported by an eleven-point catenary suspension from a stranded-steel messenger cable. Both side bracket and cross-span construction are used as required by the local conditions. There is clamped in place by a single bolt. Special pulloffs are used to increase the flexibility of the suspension.

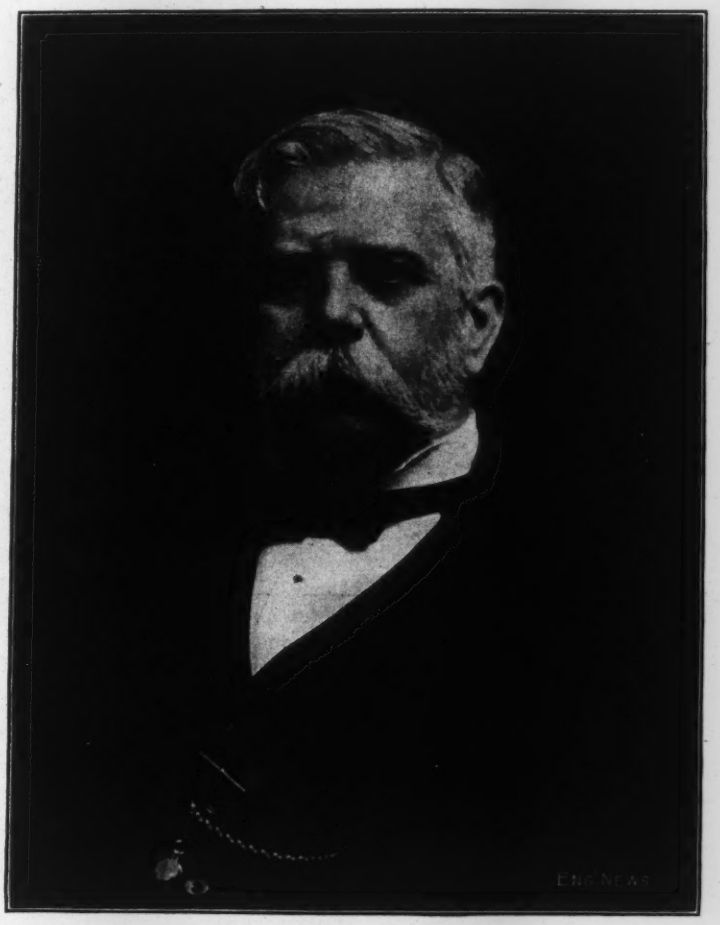
The section breakers were designed for the 2400-volt service, and at six points insulated crossings are necessary at the intersection of the 2400-volt trolley with the 600-volt trolley of a city system. On the main line, a very simple section insulator is used. This consists of paralleling the two trolley wires from the ends of each section at a suitable distance for insulation so that the pantograph bridges the two circuits for a short distance, thus avoiding interruption of the power-supply to the locomotive. The construction in the yards and sidings is simplified by paralleling the trolley from the side tracks for a short distance along the main line. This avoids the use of switch plates or similar devices. At some of these junction points the pantograph engages as many as six trolley wires.

The overhead lines are protected from lightning by arresters of a special type, installed on poles at intervals of one-third of a mile the entire length of the system.

The No. 0000 trolley is reinforced between the substations with two 500,000 circ.-mil. bare copper cables tapped to the trolley at intervals of 1000 ft. A No. 0000 negative-return wire is also installed between Rocker and East Anaconda. This wire is carried on the trolley poles and is connected to the crossbonds at intervals of 1000 ft. The rails are connected by No. 0000 bonds at every joint.

George Westinghouse

George Westinghouse, most famous of American engineers and inventors, died in New York City, on Mar. 12, in his sixty-eighth year. Mr. Westinghouse had enjoyed rugged health all his life, but became a sufferer, some 15 months ago, from an affection of the heart, which made necessary his relinquishment of business activity. He had been living quietly at his country home in Lenox, Mass., until Dec. last, when he came to New York City. Since that time, he has been confined to his room.



Geo. Westinghouse

It can be said without fear of contradiction that no American inventor has ever attained so great a success as did Mr. Westinghouse. He attained this success, however, not merely because of his inventive genius, but because he was also a great engineer, a great organizer, a man who won the highest distinction in business and financial circles. It is right, however, to record him first as an inventor, for throughout his long and busy life the work on new mechanical developments in which he was continuously engaged was of even greater interest to him than the commercial development of the great enterprises which he founded.

George Westinghouse was born at Central Bridge, Schoharie County, New York, Oct. 6, 1846. He doubtless inherited his mechanical genius from his father, who had emigrated from Vermont, and started in Schenectady, in 1856, a small factory making farmers' tools. His father's workshop had greater attraction for young Westinghouse in his boyhood days than any playground, and all his spare time was spent there during his school days. Even as a boy in the workshop, he began to invent. It is said that when he was only 15 years old, he designed and constructed a rotary engine. It is a good illustration of the fascination which this will-o'-the-wisp has always had for so many men of inventive genius, that Westinghouse returned to this difficult problem again and again. More than 30 years afterward, in 1890, the writer recalls seeing a rotary engine said to have been designed by Mr. Westinghouse, running in the old Westinghouse Electric Works, at Pittsburgh. His interest in the rotary engine at that time may be deemed prophetic of the development of the steam turbine, which began shortly afterward and in which he has in recent years taken such an active part.

The outbreak of the Civil War diverted the attention of young Westinghouse from both shop and school, and he was eager to enlist. When the war was at its height, in 1863, Westinghouse secured his parents' consent and enlisted, at the age of 17. After a short service in a cavalry regiment, he was transferred to the engineer corps of the Navy, where his knowledge of machinery made him especially useful. He served there until the close of the war, and was mustered out in 1865 as third assistant engineer.

He then entered Union College. The classical college course of that day had no relation whatever to the interests predominant in the mind of young Westinghouse. He went to college as so many boys go to college at the present day, because it was supposed to be the thing for a bright, intelligent youth to do. The president of the college, however, was wise enough to realize, even at that early day, that what was good for one student was not necessarily good for another. Before Westinghouse had finished his course, the president told him that he would be wasting his time to spend more of it in the routine studies of the college. Instead, he advised him to follow his own inclinations and enter the field of mechanical engineering, predicting, it is said, that he would become a great engineer.

While he was still in college, Westinghouse had invented a rerailing frog, and his first business venture was the manufacture and sale of this. The men who had furnished the money, however, promptly "froze out" the young inventor.

About this time young Westinghouse happened to be an eye witness of a collision between two freight trains between Schenectady and Troy and became impressed

with the need of some means by which the locomotive engineer could apply the brakes throughout the train. He studied for some time over schemes for operating brakes by the draft rigging of each car and later for brakes operated by steam. Happening to read an account of the use of compressed air in driving the Mont Cenis tunnel, he was at once impressed with the idea that compressed air would solve his problem. He filed a caveat on the invention in 1867 and with the financial aid of Ralph Baggaley, of Pittsburgh, made a crude "straight air" brake, which was applied to a four-car local train on the Panhandle R.R., in the fall of 1868. Crude as it was, it worked, and saved a wreck on its very first run.

The value of the invention to the railways was at once recognized and its introduction was rapid. The young inventor demonstrated his possession of business ability, as well as inventive genius, by organizing a company for the manufacture of the brake, in which he interested many men of prominence, but was able to retain a large share for himself. The invention of the automatic brake followed in 1872.

Successful as the Westinghouse airbrake concern was in the '70's, there came a period in the '80's when business was dull. All of the passenger cars in the country had been equipped, so that the only orders which came in were those for the construction of new cars or for repairs. In certain special classes of freight service, the use of airbrakes on freight cars had already begun in a limited way. It was evident that if the airbrake could be made applicable to freight trains, an enormous volume of business would result, many times that obtainable from passenger cars.

To achieve this, however, two things were necessary. First, a brake must be designed which could be successfully operated on long freight trains, and second, it must be made and sold at so low a price that the railways would be willing to consider its application on freight cars. In the late '80's, both of these problems were successfully solved by Mr. Westinghouse and his associates, and it would be difficult to overestimate the enormous economic advantage to the world at large as well as the number of lives saved by the solution of this single mechanical problem.

We believe that no one of the many engineering enterprises which Mr. Westinghouse founded has had so great a commercial success as has his original great invention, the airbrake; and, of course, none has had so long a history.

If the airbrake represents Mr. Westinghouse's greatest achievement in the mechanical field, his greatest work in industrial organization has been in the electrical field. The story has been many times told how, when practically the entire American electrical fraternity were confining their attention to work with continuous currents, Mr. Westinghouse had the keen business foresight to perceive the great commercial advantage possible with the alternating system. In the face of great opposition he put on the market and made a commercial success of the first alternating-current electric systems in this country. It was as the result of this successful venture that the great Westinghouse Electric Co. had its origin.

Anyone familiar with the early days of the electrical industry will recall the bitter warfare waged between the advocates of the continuous current, as represented by the Edison interests, and the alternating current, represented by the Westinghouse interests. It was a significant tribute to Mr. Westinghouse's wisdom and foresight that the American Institute of Electrical Engineers conferred upon him, in June, 1912, the Edison gold medal for "meritorious achievements in connection with the development of the alternating-current system of light and power." To have the medal which was founded in honor of his eminent rival, bestowed on Mr. Westinghouse, was an acknowledgment that he was in the right in the long and bitter controversy.

Another field in which Mr. Westinghouse's inventive genius was largely instrumental in laying the foundation, was, like the airbrake, intimately connected with the railway industry. This was the operation of switches and signals by compressed air, a natural outgrowth of Mr. Westinghouse's early work with the airbrake and later with the air signal which he developed for train equipment. It is interesting to note that throughout his long life, compressed air was a subject which especially fascinated him. His first great invention was the compressed-air brake, and his latest invention, which has been his pet hobby during the last two years, is the compressed-air spring for automobiles. Indeed, one of his patents on this air spring was issued only three days before his death.

It was characteristic of the man that at a time when enormous business and financial interests were dependent upon him, and an endless number of social engagements were appealing for his time, he appeared to find his greatest pleasure and interest in studying over the details of the compressed-air spring. A little stroke of ingenuity, which solved some puzzling mechanical problem, was to him a source of greater enjoyment than a successful financial deal involving a million dollars.

Doubtless in the fact that Mr. Westinghouse was an inventor and an engineer primarily, rather than an organizer and financier, is to be found a partial explanation of the financial vicissitudes which have attended some of his great enterprises in recent years. Yet it remains true that he was a financier and business man of great ability, as is demonstrated by the notable success of nearly all the enterprises which he established. It would have been strange, indeed, if the enormous interests concentrated in him, and for which he held himself responsible, could have been controlled and guided by any single man, no matter how miraculously great his powers of accomplishment.

Furthermore, it must be remembered that even the greatest financiers have made their mistakes. Guy E. Tripp, the present head of the Westinghouse Electric Co., recently defined business as "taking chances on probabilities." In the development of every new enterprise, to say nothing of the conduct of an established business, chances for failure always exist.

When one reviews, however, the whole of Mr. Westinghouse's long and active career, dealing so largely as it did with new and untried inventions, it is the greatest tribute to his phenomenal ability that his record was one of such uniform success.

In all the years of his long and active business life, no one had ever had reason to question in the slightest degree his honor and integrity. Of the great American fortunes now existing, it would be difficult to find one of which could be said with greater truth that it was honestly earned by great ability devoted to the world's ser-

vice from the fortune accumulated by Mr. Westinghouse.

It is a significant fact that in all his long life Mr. Westinghouse found his greatest enjoyment in work. He entered very little into social life, was rarely seen at the clubs to which he belonged, and seldom took time for recreation. He did not work, however, merely to amass money. While still a comparatively young man, he achieved financial success and thereafter he worked purely for the work's sake. His joy was in successful accomplishment.

The list of honors showered upon Mr. Westinghouse is a very long one. Many of them were noted in the biography which we published in ENGINEERING NEWS of Jan. 20, 1910, at the time of his election to the presidency of the American Society of Mechanical Engineers.

It illustrates Mr. Westinghouse's careful business foresight that he had long ago made provision for the conduct of his affairs in case of his death, so that as little disturbance as possible should result to his great business interests and those dependent upon them. The will left by Mr. Westinghouse creates a Board of Trustees, made up of his brother, H. Sherman Westinghouse, Charles A. Terry, vice-president of the Westinghouse Electric Co., and W. D. Updegraff, Director of the Westinghouse Air-brake Co. These trustees will control the interests held by Mr. Westinghouse in the numerous corporations bearing his name.

Mr. Westinghouse was married, before he was twenty-one, to Marguerite Erskine Walker, who, with one son, George Westinghouse, Jr., survives him.

It would be difficult to overestimate the debt which the engineers of the United States owe to George Westinghouse. His inventive genius, his ability as an engineer and a captain of industry, have been of enormous value to the country and to the world in the great work of engineering development that has gone on in the past half century.

Those who had the privilege of knowing Mr. Westinghouse intimately will remember not alone the great inventive genius and the successful man of affairs, but the kind friend and the man of fine, true personality.

The Progress and Status of Water Filtration

It will surprise many to learn that 17,000,000 people in the United States, or 40% of the urban population, are now supplied with filtered water. Such was the statement, with abundant statistics to back it, made by George A. Johnson, on Mar. 10, in the course of an address on "Water Purification" before the New York Section of the American Water Works Association.* The speaker ventured the prediction that by 1920, filtered water will be available for 80% of the urban population.

In number of plants mechanical filters are far in excess of slow sand filters but in population supplied the latter are way in the lead, owing largely to the fact that Philadelphia is in the slow sand class.

Although dealing with slow sand filtration, coagulation, sedimentation and hypochlorite disinfection, the paper was in effect a strong plea for mechanical as against slow sand filtration. The author claimed for mechanical filters equal or better purification efficiency, no greater and sometimes less unit cost (capital and operating expenses totaled); small area and cost of required land and ease of plant location near the city to be supplied; and no higher grade of operators than are needed for slow sand filters. Particular stress was laid upon the inability of slow sand filters to deal with high turbidities.

F. O. Dunlap (formerly chief of the Bureau of Water of Philadelphia) agreed with Mr. Johnson in most of his claims, but had some good words to say for slow sand filtration at Philadelphia. He thought the patent difficulties connected with mechanical filtration would make a dollar or two of difference per million gallons in favor of slow sand filtration. Messrs. West and Siddons, of the Philadelphia filtration plants, also agreed with Mr. Johnson in the main.

Morris Sherrerd (Newark) thought the reduction of typhoid by filtration has been greater than appears since much of the residual typhoid is due to other causes than water-supply.

John A. Kienle (New York City; formerly of Wilmington, Del.) questioned whether the cost of preliminary filtration (roughing filters) might not better be expended for sedimentation. He was convinced that mechanical filtration is better than slow sand filtration. He questioned whether the use of hypochlorite with mechanical filtration does not account for the high bacterial efficiencies now being obtained at mechanical filter plants.

Allen Hazen (New York City) was the only speaker who rose to the unqualified defense of slow sand filtration. He remarked that the slow sand filters at Washington had given such high bacterial results that there had been no occasion to use chlorine. He was gratified to hear what had been said about preliminary filters. He took ground against them years ago, since the large-grained matter which they can stop can be easily stopped by other parts of the purification plant.

As to the opposition to mechanical filters in Massachusetts, Mr. Hazen had heard it stated a few days ago that although slow sand filters had reduced the general death rate as well as the typhoid rate, mechanical filters had reduced the typhoid rate, only. Mr. Hazen was of the opinion that the use of hypochlorite has done much to change the status of water purification. Finally, Mr. Hazen expressed the hope that when Mr. Johnson revises his paper for publication he will speak more kindly of the early slow sand filtration plants, in view of the state of the art when they were built.

Prof. Wm. P. Mason (Troy, N. Y.) said that typhoid at Albany has fallen from 90 to 21 per 100,000 population since filtration was introduced, but that 14 or 15 would be a more correct figure than 21 in view of the non-resident typhoid deaths in the Albany hospitals.

*The paper, which was presented in oral abstract, will fill many pages of the first issue of the new "Quarterly" of the American Water-Works Association, which is to appear about Apr. 1. The paper will contain many valuable historical facts and many typhoid, cost and other data regarding both slow sand and mechanical filtration.

The First Power Rentals, received by the U. S. Department of the Interior under the new form of power-development permits (see "Engineering News," Dec. 12, 1912) have just been announced. The sum of $52.72 was received from the Truckee River General Electric Co., of Reno, Nev., and $367.46 from the Great Falls Power Co., of Butte, Mont.

The Proposed Water-Works for Watervliet, N. Y., noted briefly on p. 459, of our issue of Feb. 26, 1914, were authorized by a popular vote of 371 to 273 on Mar. 4. The vote on wood-stave as against cast-iron pipe for the supply was 219 to 132, in favor of wood. Solomon, Norcross & Kies, of Atlanta, Ga., reported on the project a short time ago.

NOTES

Keel of a Huge Battleship was laid on Mar. 16 at the Brooklyn Navy Yard, New York City. This has not been given a name yet, being designated as "No. 39." It will be a sister ship of the superdreadnaught "Pennsylvania," displacement, 31,400 tons; length, 600 ft.; beam, 97 ft.; draft, 28¾ ft.; speed, 21 knots.

A Premature Blast at the Snoqualmie Tunnel in the Cascade Mountains on the line of the Chicago, Milwaukee & Puget Sound Ry., killed four men on Mar. 7. According to press dispatches this is the first such accident since construction work on the tunnel was started two years ago. The tunnel will be 11,700 ft. long when completed, which date is set at Jan. 1, 1915.

A Trestle Was Wrecked recently on the Pacific Electric Ry., over Lexington, Wash., about a half mile west of the town of El Monto, Calif., due to wreckage of a county highway bridge being carried downstream against the structure. Five bents were carried away. This wreckage collected floating brush, etc., and deflected the stream against the west approach of the trestle, 500 ft. of which was scoured away.

A Ferryboat Was Rammed by a tug-propelled car-float at 5 p.m. on Mar. 17, while proceeding from New York City to Hoboken, on the North River. A Central R.R. of N. J. float struck the steel ferryboat "Ithaca" of the Delaware, Lackawanna & Western R.R., about amidships on the starboard side (the men's cabin). Three passengers were killed and several injured. The "Ithaca" was not damaged below the water line.

Waterfront Fire at Portland, Ore.—On March 12 a fire destroyed about $750,000 worth of private dock and warehouse property along the east bank of the Willamette River at Portland, Ore. The fire broke out early in the morning in some structures between Columbia Dock No. 2 and Montgomery Dock No. 1, two quay docks in the lower Albina Ferry section of the river, and in a half-hour was beyond control. The buildings along the river at this point were all of a light timber construction and there was a marked absence of either fire walls or any fire-resisting construction so that the flames spread with great rapidity and made unavailing the efforts of the fire department. The structures were destroyed for a length of 1000 ft. along the water and about 200 ft. back from the docks. In addition two large steamships, the British "Glenroy" and the American "Cricket" were badly damaged.

The dock at this location were among the oldest in the city, having been built about 25 years ago. The light timber sheds were very high and rested on long timber piles The whole area made admirable material for the rapid progress of a conflagration.

Suggestions on Fire-Resistive Construction—A subcommittee of the National Fire Protection Association has undertaken to compile a list of suggestions and cautions concerning fire-resistive construction, under the title of "Don'ts." This will be drawn so as to cover completely those features which should be avoided in design and method so that life and property may be conserved. With a view to making the list as comprehensive as possible, the committee is anxious to obtain the coöperation of all who are interested in design and construction with regard to fire-resistive character. Communications in connection with the committee's work should be addressed to W. G. Sanderson, 76 West Monroe St., Chicago, Ill.

Surplus Power from the Milwaukee Refuse Incinerator is to be used to pump water to flush the Milwaukee River as soon as the necessary plant can be got into successful operation. The incinerator ("Eng. News," July 21, 1910 and Sept. 7, 1911) has a total capacity of 300 tons a day. This is divided into three units, each of which is equipped with a 200-hp. boiler for the utilization of the heat of combustion. Ordinarily three units are employed and from 175 to 250 tons of refuse per day are burned. A 600-kw.-hr. turbo generator was installed some time ago and was operated intermittently during the first two months or so of the present year. Troubles with the machine caused a shut down about March 1. When the machine is in working order the current which it generates will be transmitted in underground conduits to the flushing-tunnel pumping station at McKinley Park, some two miles distant, and there used to operate the pump which delivers lake water into the north end of the Milwaukee River for flushing or cleansing purposes.

The Proposed New Water-Supply for Ottawa, On[illegible] been held up by court decisions which have declared [illegible] city possessed legislative authority to issue only $5,0[illegible] the $8,000,000 bonds required for the works. An o[illegible] the scheme, based on a report by Sir Alexander B[illegible] London, England, was published on pp. 1012-1015 of [illegible] of Nov. 20, 1913. In our issue of Nov. 20, 1913, p. [illegible] commented editorially on the remarkable contract [illegible] the city of Ottawa and Mr. Binnie for the engineering [illegible] involved. A summary of bids received on Feb. 3, 1[illegible] the steel pipe line was published on p. 88 of our Const[illegible] News section for Feb. 12, 1914. At an election some [illegible] ago an opponent of the water-supply scheme was [illegible] mayor.

Great Dams on the Upper Nile to be built for pow[illegible] velopment and irrigation, were described in a press d[illegible] widely circulated in the newspapers last week. The d[illegible] stated that Hugh L. Cooper had been appointed cons[illegible] hydro-electric engineer to the Egyptian government [illegible] would have charge of the work of constructing two [illegible] dams south of Khartoum, one across the Blue Nile a[illegible] across the White Nile, the estimated cost of the two st[illegible] tures being in the neighborhood of $20,000,000. W[illegible] authorized by Mr. Cooper, who arrived in the United St[illegible] on Mar. 13, to say that the report is incorrect. The [illegible] foundation for the report, out of which the story prob[illegible] ably grew, is the fact that he has at the request of the Egyptian government submitted plans for the development of power at the Assuan dam which the government engineers have now under consideration. The general conduct of the work at the Assuan dam is in charge of the under Secretary of State at Cairo, Mr. Murdoch Macdonald. Mr. Macdonald has been connected with Egyptian engineering works for 15 years, and has charge of all works for the improvement of the Nile.

The Alaska Railway Bill Was Signed By the President on Mar. 12, after having passed the Senate on Mar. 10, by a vote of 42 to 27. The bill passed the House of Representatives on Feb. 18, as noted in our issue of Feb. 26. The bill provides for the building of 1000 miles of railway from the Alaskan coast to the interior coal fields, the route to be selected by the President. The President is also to decide whether or not the existing railway lines in the territory shall be purchased to form a part of the government system, and whether the railways when built shall be operated by the government or under lease to private companies.

An Injunction Against the Completion of the Catskill Aqueduct and its associated dams and reservoirs now well toward completion to provide a new half-billion-gallon water-supply for New York City is sought by a petition filed in the Federal District Court, New York City, on Mar. 16. The petitioner is the Ramapo Water Co. (215 Montague St., Brooklyn, N. Y.), which alleges that its state charter and the payment by it of a $3125 incorporation fee constitutes a contract which give it the right of building water-supply works and conveying water therefrom for the supply of cities; and that the works now being built by the Board of Water Supply of New York City are in effect an appropriation of its rights under the contract, without due compensation. The company asks that the dams, reservoirs and aqueduct built in alleged contravention of its rights be either removed by the Board of Water Supply or else turned over to the company. Many of our readers will remember the scandal created a dozen years or so ago about a proposed contract between the Ramapo Water Co. and the city of New York for a new water-supply.

A Quick Replacement of Railway operating facilities, after a serious fire in the station of the New York, New Haven & Hartford R.R. at Hartford, Conn., on Feb. 21, is noteworthy. This station is the headquarters of the Midland division of the road, is the meeting point of three divisions, the Midland, the Shore Line and the Western, and is also used by the Central New England Ry. It is the fourth largest station on the New Haven system and has a daily movement of 132 trains in and out. The fire occurred at 2:25 p.m., Saturday, and gutted the station, destroyed the ticket, baggage, express and train dispatchers' offices and blocked one of the four tracks passing through the station. This prevented the communication of train orders, cut off the supply of tickets and threatened to paralyze the whole system at an important point.

There were three dispatchers in the headquarters at the time of the fire in charge of moving the freight and passenger traffic over the several lines; safety and disposition of the traffic depended on their quick action. When the wires were burned out, one of the despatchers seized his train sheets jumped on a switch engine which ran to a signal tower a half mile east of the station and from there he directed the operation of his trains temporarily. The second operator turned over the operation of his branch to the Providence

office, w[illegible] the third operator hurried to the Western Union Telegra[illegible]ce in the city and worked from there. As a result in [illegible]minutes the system was running again. In that time, th[illegible]maged wires were being picked up and a despatcher [illegible]ce established in another building; this was in full op[illegible]n by 7:30 p.m.

At [illegible] the General Manager, General Superintendent, Telegra[illegible]uperintendent and other officers left New Haven on a sp[illegible] train to take charge. Carpenters, laborers and linemen [illegible] been collected by telephone and telegraph at points [illegible]r away as Boston and six special trains with repair equipment were hurried to the scene. One train carried lumber for a new station, and this was on hand by seven o'clock. At 4:00 p.m. the railroad had 150 laborers at work and by 9:00 p.m. 150 carpenters. An emergency boarding train, with a kitchen and sleeping accommodations for 120 men, came from Hartford at 8:00 p.m., and at midnight served dinner to 350. The work of removing the débris, stringing the wires, and building the new station was divided under special foremen. By 10:30 p.m. Saturday the blocked track had been cleared. By 7:00 a.m. Monday morning the new station, 30x150 ft., steam heated and electric lighted, was open to the public. A new supply of tickets had been printed in Boston on Sunday and were on sale Tuesday.

PERSONALS

Mr. D. M. McKey has been appointed Locating Engineer of the Seaboard Air Line Ry., succeeding Mr. H. S. Thomas, promoted.

Mr. George S. Vandewalker, Assistant Postmaster, of Ann Arbor, Mich., has been appointed Manager of the municipal water-works, at a salary of $1800 per annum.

Mr. A. M. Traugott has been appointed Division Engineer of the Virginian Ry., with headquarters at Princeton, W. V., succeeding Mr. B. T. Elmore, resigned as noted elsewhere.

Mr. W. E. Ricketson has been appointed Mechanical Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., succeeding Mr. C. A. Brandt, promoted as noted in our issue of last week.

Mr. L. A. Murr has been appointed Assistant Engineer of the Seaboard Air Line Ry., with office at Portsmouth, Va., succeeding Mr. R. M. Coburn, transferred to the Chief Engineer's office.

Mr. W. W. Slater, Signal Engineer of the Southern Pacific Ry. since 1885, has been retired on a pension. Mr. Slater began railway work in 1864, at the age of 15 years, as a telegraph messenger.

Mr. C. J. Franklin, recently General Superintendent of the Portland Railway, Light & Power Co., Portland, Ore., has opened an office in Portland for private practice as an expert in public-utility work.

Mr. Frank Cone, recently Assistant Superintendent of the La Crosse division of the Chicago, Burlington & Quincy R.R., has been promoted to be Superintendent of the Beardstown division, at Beardstown, Ill.

Mr. E. A. Kingsley, Assoc. M. Am. Soc. C. E., former State Highway Engineer of Arkansas, has been made Engineer in charge of the highway work of District No. 5, Bell County, Tex., which is to cost $600,000.

Mr. F. H. Buchanan, recently Supervisor of Signals of the Vandalia R.R., Terre Haute, Ind., has been appointed Signal Engineer of the Pennsylvania R.R. lines west of Pittsburgh, with headquarters at Pittsburgh, Penn.

Mr. G. W. Alden, for the past 10 years connected with the McMyler-Interstate Co., Bedford, Ohio, is now Western Sales Manager of the Ohio Locomotive Crane Co., Bucyrus, Ohio, with offices in the Fisher Bldg., Chicago, Ill.

Mr. Seymour Van Santvoord, of Troy, N. Y., has been appointed Chairman of the Public Service Commission, Second District, New York, succeeding Mr. Martin S. Decker, resigned as chairman, but who remains a member of the commission.

Mr. J. N. Kinney, for the past seven years connected with the American Hoist & Derrick Co., St. Paul, Minn., is now Eastern Sales Manager of the Ohio Locomotive Crane Co., of Bucyrus, Ohio, with offices at 30 Church St., New York City.

Mr. B. T. Elmore, recently Division Engineer of the Virginian Ry., at Princeton, W. Va., has been appointed Engineer of Roadway and Track of the Division of Valuation, Interstate Commerce Commission, Eastern district, with headquarters at Washington, D. C.

Mr. Henry R. Kent, M. Am. Soc. M. E., former Vice-President of Westinghouse, Church, Kerr & Co., New York City, announces that he has formed a partnership with Mr. Carl M. Vail under the firm name of Henry R. Kent & Co., Engineers, 141 Broadway, New York City.

Mr. J. M. Morrison, Engineer and Superintendent of Structures of the Central Vermont Ry., St. Albans, Vt., has been appointed Chief Engineer of the Southern New England Railroad Corporation and the Southern New England Ry. Co. He will retain his headquarters at St. Albans.

Mr. J. B. Jenkins, Assistant Engineer of the Baltimore & Ohio R.R., at Baltimore, Md., has been appointed Valuation Engineer of the railway company, under Mr. Francis L. Stuart, M. Am. Soc. C. E., Chief Engineer, and Mr. H. R. Talcott, M. Am. Soc. C. E., Chairman of the Valuation Board of the railway.

Mr. Hugh L. Cooper, M. Am. Soc. C. E., who after the completion of the Mississippi River dam at Keokuk, Ia., last summer went with his family for a long European tour, arrived in New York on Mar. 13. During his seven months' absence Mr. Cooper traveled over 30,000 miles by automobile through various parts of Europe and northern Africa.

Mr. Warrick R. Edwards, M. Am. Soc. C. E., has resigned as Assistant Engineer of Bridges of the Baltimore & Ohio R.R. to become Engineer of Bridges of the Eastern district, Division of Valuation, Interstate Commerce Commission, with headquarters at Washington, D. C. Mr. Edwards has been connected with the bridge department of the Baltimore & Ohio R.R. since 1894.

Mr. Stanton Ennes, formerly Superintendent of the Great Northern Ry., at Superior, Wis., has been appointed General Superintendent of the Western Maryland Ry., at Baltimore, Md., succeeding Mr. A. R. Merrick. Mr. Ennes is a native of St. Louis, Mo., and began railway work in 1881 as a telegraph operator on the Texas & Pacific Ry. He was Division Superintendent of the Western Maryland Ry. in 1904 and 1905.

Mr. W. W. Patch, M. Am. Soc. C. E., recently Project Engineer, United States Reclamation Service, Klamath Falls, Ore., has opened an office at 12 Geary St., San Francisco, Calif., as a Consulting Engineer, giving special attention to water supply and irrigation. Mr. Patch was engaged for 11 years on the additional water supplies for the cities of Boston, Mass., and New York. He has been for the past nine years in the employ of the U. S. Reclamation Service as Constructing and Project Engineer in South Dakota, California and Oregon.

Mr. Charles D. Jameson, M. Am. Soc. C. E., formerly Supervising Engineer and Architect to the Imperial Chinese Board of Foreign Relations, Peking, China, and since June, 1911, in charge of the Red Cross Society flood-prevention work on the River Whwai, in Central China, is in Washington, D. C., to report on the project for which he has prepared definite plans. This project has been approved by the Chinese Government and will cost approximately $20,000,000. An account of the conditions in this section of China and the proposed plans for relief were given in an article, abstracted from a preliminary report by Mr. Jameson, in "Engineering News" of Sept. 25, 1913.

Mr. W. S. Murray, F. Am. Inst. E. E., of McHenry & Murray, Consulting Engineers, New Haven, Conn., has been appointed Consulting Engineer of the New York, New Haven & Hartford R.R., in general charge of all electrical engineering and construction. It is officially announced that following the substantial completion of the construction of the system for electrical operation between New Haven and New York, Mr. Murray will enter closer relations with the railway company, and his jurisdiction will be extended to include the electrical features of operation in addition to electrical construction. He will continue with the firm of McHenry & Murray in general consulting practice as before. Mr. Murray was formerly Electrical Engineer of the New York, New Haven & Hartford R.R.

Mr. Garrett Davis, who has been Superintendent of the Louisiana division of the Chicago, Rock Island & Pacific Ry., at Eldorado, Ark., since 1908, has been appointed Division Engineer of the Oklahoma division, at El Reno, Okla. Mr. Davis was born in Kentucky in 1855, and he began engineering work in 1874 as a chainman with the Cincinnati Southern Ry. In 1876 he was engaged in railway contracting. From 1877 to 1878 he was Resident Engineer of the Burlington, Cedar Rapids & Northern Ry., and was promoted successively to be Roadmaster, Division Engineer and Assistant Chief Engineer. When the railway was absorbed by the Chicago, Rock Island & Pacific Ry., he was made Principal Assistant Chief Engineer of the Northern district, and subsequently District Engineer, at Cedar Rapids, Iowa.

Mr. H. R. Talcott, M. Am. Soc. C. E., Engineer of Surveys of the Baltimore & Ohio R.R., Baltimore, Md., has been appointed Chairman of the railway company's valuation board. Mr. Talcott was born in Richmond, Va., in 1861. He entered the railway service in 1878 as a rodman on preliminary surveys for the Chesapeake & Ohio Ry. Following November, 1889, he was Chief Engineer of the Seattle, Lake Shore & Eastern R.R., at Seattle, Wash., and for a time Vice-President of the Seattle Coal & Iron Co. In 1898 and 1899 he was Engineer for the contractor on the construction of the White Pass & Yukon R.R. in Alaska. He returned East in November, 1901, to become Treasurer of the Taft-Pierce Manufacturing Co., Woonsocket, R. I., but in 1903 returned to railway engineering work on the Baltimore & Ohio R.R., at Somerset, Penn. Since 1905 he has been Engineer of Surveys.

Mr. Ezra B. Whitman, M. Am. Soc. C. E., Water Engineer and President of the Water Board, Baltimore, Md., has resigned to enter private practice as a partner of Mr. John E. Greiner, M. Am. Soc. C. E., former Engineer of Bridges of the Baltimore & Ohio R.R., Consulting Engineer, Fidelity Bldg., Baltimore, under the firm name of Greiner & Whitman. Mr. Whitman graduated from Cornell University in 1901, and for three years was a Consulting Engineer with offices in New York City. He returned to Cornell University in 1904 for a year's special course, after which he became connected with the Baltimore city engineering staff as Engineer of the Wallbrook Sewage Testing Station, and as Division Engineer of the sewer department. Subsequently he was promoted to be Water Engineer and President of the Water Board at a salary of $4000 per annum. His resignation takes effect about Apr. 15.

Mr. James C. Boyd, M. Am. Soc. C. E., formerly Chief Engineer, has been elected Vice-President of Westinghouse, Church, Kerr & Co., New York City, and will have charge of all the engineering and construction work of the company. Mr. Boyd began his engineering experience in 1891, after three years at the Massachusetts Institute of Technology, on survey work with the Bangor & Aroostook R.R. in Maine. For five years, 1897 to 1902, he was with the Boston Elevated Ry., first as Assistant Engineer and then as Division Engineer in charge of designs, surveys and construction on the Charleston, Subway and a part of the Atlantic Ave. divisions. For a year, 1901 to 1902, he was in charge of maintenance, structures, tracks and buildings of the Boston Elevated Ry., and the following year he was Engineer in charge of new construction and of bridges and buildings of the Boston & Albany R.R. Since 1903 Mr. Boyd has been connected with Westinghouse, Church, Kerr & Co., New York.

OBITUARY

William J. Kinser, Vice-President and Treasurer of the Kinser Construction Co., Terre Haute, Ind., was among those who lost their lives in the fire which destroyed the Missouri Athletic Club house, St. Louis, Mo., Mar. 9.

Stuart Wood, junior member of the firm of R. D. Wood & Co., manufacturers of cast-iron pipe, Philadelphia, Penn., died last week from heart disease at his home in Philadelphia, aged 62 years. He was a well-known citizen of Philadelphia and a member of many clubs. He was Treasurer of the American Academy of Political and Social Science.

Roger Tiffit Holloway, Jun. Soc. C. E., son of Henry F. Holloway, M. Am. Soc. M. E., died Mar. 12, at the home of his father in Montclair, N. J., after an illness of only a week. He was 28 years old and a graduate of Cornell University, with the class of 1908. For two years following his graduation he was a partner of Charles A. Mead, M. Am. Soc. C. E., under the firm name of Mead & Holloway, New York City. For the past three years he had been engaged in construction work as the representative in this country of Bagley, Mills & Co., London, England, agents for the Carl Still by-product coke oven system.

ENGINEERING SOCIETIES

COMING MEETINGS

EFFICIENCY SOCIETY.
Apr. 4-11. First annual conference in New York City. Offices at 41 Park Row, New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
Apr. 16-18. Spring meeting in New York City. Secy., Prof. J. W. Richards, Lehigh University, Bethlehem, Penn.

AMERICAN DRAINAGE CONGRESS.
Apr. 22-25. Annual meeting at Savannah, Ga. Secy., J. R. Gray, Chamber of Commerce, Savannah.

IOWA STREET AND INTERURBAN RAILWAY ASSOCIATION.
Apr. 22-25. Annual meeting at Waterloo, Iowa. Secy., H. E. Weeks, Tri-City Ry. & Light Cos., Davenport, Iowa.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 5-7. Annual meeting in Chicago, Ill. Secy., Franklin H. Wentworth, 87 Milk St., Boston, Mass.

AIR BRAKE ASSOCIATION.
May 5-8. Convention at Detroit, Mich. Secy., M. M. Nelis, 53 State St., Boston, Mass.

AMERICAN WATER-WORKS ASSOCIATION.
May 11-15. 34th Convention at Philadelphia. Secy., J. M. Diven, 47 State St., Troy, N. Y.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 18-21. 6th convention in Chicago, Ill. Secy., C. G. Hall, C. & E. I. R.R., 922 McCormick Bldg., Chicago, Ill.

MASTER BOILER MAKERS' ASSOCIATION.
May 25-28. Convention at Philadelphia, Penn. Secy., H. D. Vought, 95 Liberty St., New York City.

International Association of Fire Engineers—The annual convention will be held Oct. 20-23 in New Orleans, La. The sessions of the convention will be held at the Grunewald Hotel. The exhibits will be housed in the Washington Artillery Barracks. The engine and apparatus demonstrations will take place on Canal St., said to be the widest street in the world. The Secretary is James McFall, of Roanoke, Va.

Minnesota Surveyors' and Engineers' Society—At the annual meeting in St. Paul, Feb. 24-25, officers for 1914 were elected as follows: President, Walter F. Brooks, Mankato, Minn.; Secretary, Geo. H. Herrold, St. Paul, Minn.

American Water Works Association, New York Section—The second lunch and meeting of this local section, which comprises all members of the American Water Works Association resident in the States of New York and New Jersey, was held in New York on March 10.

After the lunch, it was announced that the Governing Committee had organized by selecting Morris Sherrerd (Newark, N. J.) as President and Allen Hazen (42nd St. Building, New York City) as Secretary. A canvass had shown that a considerable majority of those voting preferred to continue having the sectional meetings consist of a lunch, followed by business proceedings and papers, rather than an evening session in a hired hall.

Geo. A. Johnson, consulting engineer, New York City, presented an oral abstract, with lantern slides, of a notable historical and statistical paper on "Water Purification," which may be found abstracted elsewhere in this issue.

"The Newark Water-Works," chiefly as regards the impounding reservoirs in the Pequannock drainage area, was the subject of a lantern-slide talk by Herman Rosenstreter, an engineer of the water-works of Newark, N. J.

New England Water Works Association—At the monthly lunch held in Boston, on March 11, R. K. Hale, for the Executive Committee, announced that an index of the Journal from its beginning to the present time was being compiled, to be completed, it was hoped, within a year.

John O. Hall, for the committee appointed to obtain legislation making water bills a lien on property, said that a hearing on a bill with this end in view, before the Committee on Taxation, was held on Jan. 22, and that subsequently the legislative Committee reported "leave to withdraw." Members of the Committee stated that favorable action was not taken, on account of the extra labor to conveyancers, which was out of proportion to the amount of money lost through the lack of a lien on property.

Action on the final report of the committee on Standard Specifications for Post Hydrants, owing to the lateness of the hour when the matter came before the meeting, was postponed to a special meeting to be held to April.

A paper by W. S. Johnson, of Boston, on "Some problems Connected with the Design of Small Water-Works Systems" is reserved for separate treatment.

Joseph N. Mc Kernon (engineer and superintendent, Plainville (Conn.) Water Co., presented a paper entitled "A Study of Rates of the Private Water Companies in Connecticut." The paper consists of an analysis, accompanied by many elaborate diagrams, of the water rates and financial data of 68 Connecticut Water Companies.

Of the 68 companies studied, 45 supply communities of 3000 population or less, while only two supply communities of over 100,000 population. In spite of the inequity of fixing rates by comparison, the rates in different communities do show a remarkable uniformity, indicating that they were largely fixed by this method. Of the 65 companies 22 of the companies are not paying dividends, and 43 of them do not set aside anything for depreciation. When they are earning money there is a tendency to pay too much in dividends.

Owing to lack of time the discussion was somewhat hurried and unsatisfactory.

Engineering Literature

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CORRESPONDENCE

Title-Page Dates Again

Sir—We entirely agree with Mr. Foss, of the McGraw-Hill Book Co. (p. 379 of "Eng. News" of Feb. 12), that the announcement of a new edition of a book, with a new date, when no important changes have been made, is an injustice to the purchaser.

Beginning with the second edition, 42 years ago, we have stated upon the title page of "The Civil Engineer's Pocket-Book" the total number of copies printed; and, during the last few years, we have stated also, upon the title page, the number of the "issue" (our "issue" corresponding to Mr. Foss's "impression"), as well as that of the "edition."

We think that the latest date should be stated (as indicating that the issue in question is the latest we have to offer, up to that date), but there is no reason why the "edition" date should not also be given; and we therefore propose giving, to all but the first printing of each edition, a double date, such as "1909-1913," or "1909, corrected to 1913."

TRAUTWINE COMPANY.

257 S. Fourth St., Philadelphia, Penn.,
Feb. 16, 1914.

REVIEWS AND NOTES

Engineering Education and Opportunities in England

ENGINEERING AS A PROFESSION: Scope, Training and Opportunities for Advancement—By A. P. M. Fleming, M. I. E. E., and R. W. Bailey, Principal of the Technical Institute, Crewe. London, England: John Long, Ltd., Norris St., Haymarket. Cloth; 5x8 in., pp. xii + 288. 2/6, net.

It is the aim of the authors to "give a broad general outline of the field of engineering activity for the benefit of those who have only a popular conception of engineering matters," and "to supply a knowledge as to what constitutes a suitable source of training." So far as English conditions are concerned, we believe, the authors have admirably fulfilled their aim.

Engineering education elsewhere than in England is but lightly treated, in one chapter; and while some interesting comparisons are drawn, the authors' knowledge of American institutions seems sadly deficient. Nevertheless, we venture the opinion that the book will be read by American engineering instructors and engineers with as much interest as by Englishmen, for there are many points in the English system which are worth studying, and which the authors have explained in a remarkably clear and entertaining way.

The first chapter is addressed more directly to parents and guardians who are considering the suitability of engineering as a profession for their sons or charges. This chapter gives a brief sketch of the evolution of engineering, and classifies engineering work in its various branches. Training for these branches is outlined, with the cost of acquiring such an education. Comparisons are made with the training required for other professions.

The total cost of a technical education, covering a three-year college course and a three-year apprenticeship, is stated to amount to between $3500 and $5500. At 23 years of age, it is stated, the youth should be qualified to obtain a position in which he can support himself. Broadly speaking, the conclusion is that so far as cost of training, length of time spent in training and the initial qualifications are concerned, engineering ranks equally with the other learned professions.

The following is the authors' outline of the qualifications of a youth who would be an engineer:

He should have an aptitude for mathematics and natural sciences, as well as a taste for mechanical contrivances, and in addition to be a successful engineer he should have the keen business instinct and the ability to argue logically so as to be able to set forth clearly and concisely his views on any problem he may have to consider. He should have a good physique. Robust health is probably more essential in engineering than in most other professions, since, in addition to the strenuous nature of engineering training, much of an engineer's life may be spent out of doors under exposed conditions, often in tropical or other severe climates.

The training of the would-be engineer the authors divide into three important phases—general education, technical education, and practical training. The need of a good general education is emphasized because there is a popular belief that this is a nonessential. The authors recommend a preparatory-school education such as is necessary to pass the matriculation examination of London University, an outline of which is given.

A list of elementary schools is given, together with descriptions of their equipment for training prospective engineering students, the tuition fees, scholarships, etc. There is a similar list of colleges, universities and technical schools. A description of the engineering courses at London University, the degrees awarded, etc., is of much interest both to engineers and to engineering instructors in this country. Practically all the English universities now give three-year courses in the four main branches of engineering—civil, mechanical, electrical and mining.

It is the third phase of engineering training, however, that differs most essentially from that given in American institutions. In England they have never gotten away from the conviction that every would-be professional man—merchant, mechanic or shoemaker—must serve his years of apprenticeship before he is qualified to earn a living. This conviction and the keener competition for engineering positions makes a technical education merely a stepping stone to an apprenticeship with an engineering firm.

The old-time apprentice not only contributed his labor to his employer, but actually paid his employer a premium for being allowed to work and learn. A descriptive list of well known electrical and mechanical works which have apprentice systems shows that many firms still require premiums, although the more progressive either take pupils free, or even depart so far from English tradition as to pay the apprentices small wages. Among those which do pay wages are the English branches of our General Electric Co., Westinghouse Electric Co. and Western Electric Co.

Such apprentice systems for civil-engineer students are practically unknown in this country, but are recommended by the authors, who indorse such training because "apart from the development of character it tends to produce, the importance of workshop training lies in the experience and confidence it begets in the handling of all kinds of engineering appliances."

In regard to training in civil engineering, the authors state further:

General courses of practical training in civil engineering are usually carried out on the pupilage system, extending over a period of two or three years, and the premiums required are usually heavy, often as high as $1000 per annum. In certain instances with some colleges in England and in India special arrangements are sometimes made with local firms, or in connection with state engineering projects, for students to obtain practical training without having to pay a premium. . . . . .

Armed with his technical knowledge the student is able to acquire his practical experience much more readily, so that, in some firms the length of the apprenticeship course and consequently that of his complete training may be reduced one or even two years. Moreover, experience shows that it is much easier for a young engineer to obtain a position when his training is completed in works than in college, since, if he has served his firm creditably, he is frequently retained on their staff, or may be recommended by them for a suitable position among their clients.

It is also possible to sandwich in the practical training between the years or semesters of a college course, various universities having special arrangements with engineering and manufacturing firms for this purpose.

Chapter III, on the facilities for obtaining practical training for a minimum financial outlay, contains many an interesting side light on technical education in Great Britain. One of the chief difficulties of needy youths is not in getting a college course, for there are a great many schlorships available for worthy applicants, but in finding the means to support themselves during the period of acquiring the necessary practical training!

Another condition which will surprise Americans is explained in this bald, frank statement in regard to applying for a chance to obtain practical training:

Unfortunately vacancies in such courses are usually overapplied for, and there is always the possibility that a brilliant and ambitious youth without any influence may be crowded out by others having influence, but in other respects not so deserving. It is, therefore, important not to place all reliance in ability, but to lose no opportunity during the course in technical training to become acquainted with the regulations governing admission to engineering firms, and to make use of any influence, recommendation, or introduction that may be commanded. Other things being equal, a man with a degree possesses an advantage over one without this distinction, and for this reason alone a degree will be found helpful; however, it is necessary to emphasize that too much value should not be set upon the degree itself.

Chapter IV, on engineering appointments, gives the scope and remuneration of general appointments and is of particular interest to employed engineers in this country. The salaries of assistant engineers for consulting engineers and contractors vary from $500 to $3000 per annum. Engineering posts on the staff of the London County Council range from $500 to $10,000 per annum; $500 to $2500 for various junior posts; $2500 to $5000 for heads of departments and assistants.

In mechanical and electrical engineering the salaries range as shown in the accompanying table:

	Per Annum
Estimators and clerical staff requiring some engineering training	$375 to $750
Testing, inspecting and erecting engineers	375 to 1000
Draftsmen, and, in the case of electrical firms, designers	375 to 1300
Superintendents and departmental works managers	1500 to 3750
Chief draftsman	1500 to 2500
Chief engineer	3750 to 6000

Other salary tables are of equal interest. Appointments to positions abroad and in the colonies usually carry considerably larger salaries.

The foregoing, we believe, gives a fairly good idea of the contents of the book. The contrasts between technical education and engineering employment in England and in this country, while not commented upon, are in many cases striking to the American reader; and there is much food for thought in the English situation.

While the premium-apprentice system is largely the survival of an ancient custom, it is kept alive only because of the keen competition and struggle for existence among young engineers, due to the overcrowding of the profession; a condition which there is some reason to believe this country is fast approaching. Whether our ideas and institutions are too democratic to solve the problem in the same way remains to be seen.

⁂

THE NEW PUBLIC HEALTH—By Hibbert Winslow Hill, M. D., Director, Institute of Public Health, London, Ontario. [First published as a series of eleven monthly articles by the "Journal-Lancet" of Minneapolis, under the auspices of the Minnesota State Board of Health.] Minneapolis, Minn.: The "Journal-Lancet." Cloth; 5x8 in.; pp. vi + 128.

Public health as here considered relates almost wholly to communicable or infectious diseases. The new public health aims to control these at the source, which is the infected person, by measures which will prevent inf[illegible] material from escaping from the infected persons to [illegible] people.

Among other topics the author discusses, [illegible] the general heading, "Community Defense," the publi[illegible] engineer, laboratory and statistician.

The book is written in clear, forcible langu[illegible] an experienced epidemiologist, and deserves wide [illegible]

⁂

A Monumental Contribution to Applied Hydraulics

Reviewed by ALLEN HAZEN*

THE CONTROL OF WATER AS APPLIED TO [illegible]IGATION, POWER AND TOWN WATER SUPPLY [illegible]—By Philip A. Morley Parker, Assoc. M. Am. Soc. [illegible] New York: D. Van Nostrand Co. Cloth; 6x9 in., pp. vii + 1055; 273 text figures. $5, net.

This volume of 1055 closely printed pages contains twice as much material as Turneaure & Russell's "Public Water Supplies" and more than three times as much as Fanning's "Water Supply Engineering." It is a most interesting and valuable contribution to the literature of applied hydraulics. Little time is spent on preliminaries. The author gets into his subject at once and with so much energy that the reader has to keep his wits about him to follow. The work, perhaps, like many of the best, is very unequal in quality. Many hydraulic questions are taken up in novel, interesting and helpful ways, and frequently from the standpoint of intimate personal knowledge and experience. Other subjects are treated in more of an editorial way and still others but slightly, if at all. Thus one will find but little upon ice and frost conditions, which are often of controlling importance in northern designs.

The book might almost be characterized as a collection of most interesting articles upon selected hydraulic subjects connected by briefer statements of other matters.

The work bears evidence of painstaking study of engineering literature from many lands. The impression created by references to so many works is one of surprise that there is so much hydraulic literature in the world. The references to well known publications will be easily followed, but there are innumerable references to publications from remote parts of the world that will not easily be secured. It is unfortunate that references to many of these publications are not given in greater detail, mentioning places and dates as well as authors' names.

The volume opens with some tables of fundamental values and ratios. The second chapter treats of the general theory of hydraulics. The statements are usually clear and accurate; formulas are freely used and a good working knowledge of mathematics on the part of the reader is assumed. One must be really interested in the subject to follow, where the symbols and formulas are thickest, but one who takes the trouble to do so will be repaid by many novel points of view and by references to investigations and work not found in other manuals.

The author is to be commended for keeping constantly in mind the changes in hydraulic conditions that grow out of the viscosity of the water at points near and below the critical velocity. These differences, pointed out clearly in the second chapter, are followed throughout the book and throw a helpful light upon experiments and conditions at relatively low velocities. These are especially important because they account for many results not otherwise to be explained and because it is easy by failing to recognize their character to fall into errors, by assuming that they should follow the laws that really do apply at higher velocities.

In Chapter III the gaging of streams and rivers is discussed. Among these will be found a description of a novel method called "chemical gaging." The author, by means of a simple apparatus, applies at a fixed rate, a concentrated solution of salt to rapidly flowing water that is to be gaged. It is only necessary to apply it for a minute or two, and a sample of the water taken a short distance down stream to secure mixing is used to determine the resulting proportion of salt. The author states that the portable apparatus described is adapted to quantities up to 100 cu.ft. per sec., with an accuracy of 1%. The discussion of a proper coefficient for Venturi meters is novel and convincing, and throws further light upon a question recently discussed in the columns of "Engineering News."

In Chapter IV weirs and weir formulas are discussed. The various well known experiments are compared kindly, but without favor and reasons are shown for differences growing out of the methods used by the different investigators. A novel discussion is that of the "damping ratio," in which

*Of Hazen & Whipple, Consulting Civil Engineers, 30 East 42nd St., New York City.

the size of the connection between the water above the weir and the measuring chamber is discussed with reference to the effect of waves and irregularities in flow. A surprisingly large possible influence is found. This is used to account for some of the unexplained deviations in Bazin's experiments. The practical construction of weirs is considered at length, and especially methods of obtaining accurate results with silt-carrying waters.

Chapter V relates to orifices and the application of the principles which govern them to calculating discharge through sluice gates and other openings actually existing in hydraulic works.

Chapter VI is one of the most interesting in the book. In it the collection of water and flood discharge are discussed. The works of FitzGerald and Freeman in regard to storage are fully recognized and also the work of the U. S. Geological Survey in stream gagings. Indian and Australian records are freely used. The practice of English engineers of keeping runoff records as private information is severely criticized. The author states, "that in most capitals except London, a fair amount of accessible information exists." The discussion of rainfall is comprehensive, and the comparative deficiency of rainfall records in America is pointed out and will be a surprise to American engineers. The relation between rainfall and runoff is discussed at length, and in connection with a most interesting classification of climates. Such unusual conditions as the runoff from glacial streams are considered. The method of taking into effect the ground-water storage, as developed by Vermeule in his report to the Geological Survey of New Jersey, 1894, is used at length. The determination of reservoir capacity is discussed, general methods being given, and especially figures derived from British practice and the gradual development of that practice is outlined. On the whole, this chapter gives an unusually vivid picture of runoff and storage conditions over the whole world and of the effect of climate.

Chapter VII deals with dams and reservoirs. The discussion of earth dams runs through many pages. A most interesting part of it is that relating to securing conditions of stability where it is not feasible to carry the core-wall to impervious underlying material. Both theory and abundant examples drawn from actual practice are discussed. Masonry dams are also discussed in an interesting way, but the consideration of ice thrust, important in northern climates, is given only passing notice, and the question of upward pressure from water below has received but scant attention. Much space is given to computation of stresses, but expansion joints and drainage are not considered in connection therewith. Curved and arch dams are discussed and also reinforced-concrete buttressed dams of various types.

Chapter VIII relates to pipes, their hydraulics and the material and methods of their construction. Tutton's formula (Jour. Assoc. of Eng. Soc., Vol. 23, 1899) is preferred for computing flow. A method of determining the velocity of flow in a pipe by putting a dye in the water and observing the time at which the colored water appears at some point down the line is described at length and, upon the statements given, seems worthy of further investigation. Designs for cast-iron pipe from various parts of the world are compared and steel and wood-stave pipe are mentioned.

Chapter IX relates to open channels. The author, having previously discarded Kutter's formula for pipes, expresses his disapproval of it for open channels, and states that "the reason for its use is to be sought not so much in any real physical truth underlying the formula, as in the fact that the statement of Kutter's n forms a very convincing description. . . . . The continued employment of this formula is, therefore, not surprising, but it is to be hoped that it may be rapidly abandoned. At present, unfortunately, Kutter's n is considered by many engineers to be a species of short-hand description of a river and consequently familiarity with the formula is necessary in order to comprehend the work of any engineer employing it."

Some pages are devoted to the backwater function, and others to the transportation of sediment by water in channels.

Chapter X treats of the filtration and purification of water. It discloses a wide study of literature, English, German, American and Colonial. The comparisons made in it are frequently novel and interesting. Many parts are well handled but one misses the first-hand familiarity with many of the problems that the author shows in some other subjects.

In Chapter XI special problems connected with municipal water-supplies are considered, and the size of the distributing reservoir is discussed in an interesting way, though without much regard to fire-service conditions which are often controlling in America. The directions for building a service reservoir are hardly to be considered as sufficient and few American designers would agree with the recommendation that vaulting should not be used for the roof because of the difficulty of draining the spaces over the piers.

Chapter XII discusses irrigation, a subject with which the author seems to have had an unusually intimate experience. His Indian experience is reflected and the reader gets a clear-cut idea of many of the conditions that have been met. The discussion of the works for handling water upon soft and pervious materials where hard foundations cannot be obtained, run through many of the pages. The questions of absorption, leakage and of the various control works are all discussed.

One of the most interesting parts of the book is the treatment of the silt question, and Kennedy's law (Proc. of the Inst. C. E., Vol. 119, page 282) receives extended consideration. This law is directed to the design of a system of canals and distributors in an irrigating system, so as either to prevent the deposition of silt, or else to permit its deposition only at determined places. The relation between the mean velocity and the depth of canal to prevent deposition of silt of varying degrees of fineness is discussed, and a "silt classifier" is described, by which the silt carried by any water may be examined with reference to its depositing power. Tables of dimensions of canals that will keep themselves clear are given, based upon Indian experience. The reviewer feels that the application of similar methods to the study of the problem of the self-cleansing slope in sewers of various sizes might lead to important results.

In the remaining chapters of the book are treated such varied subjects as movable dams, hydraulic machinery, the hydraulics of contracting and expanding pipes, valves and valve motions, water-hammer, ejectors, siphons, the removal of air from siphons, air lifts, air compression, hydraulic rams, resistance to motion of solid bodies in water, impact of water, turbines and centrifugal pumps. The work closes with a brief treatise on concrete, iron and other materials of hydraulic construction.

In the appendix are a few tables and a number of hydraulic diagrams relating to pipes, channels and weirs.

The work throughout shows a surprising industry in collecting the literature of the whole subject and originality in treatment, together with much entirely new material. Its use as a manual would be facilitated by some rearrangement, and by better headings and indexing.

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Vacuum Cleaning

VACUUM CLEANING SYSTEMS: A Treatise on the Principles and Practice of Mechanical Cleaning—By M. S. Cooley, Mechanical Engineer in Office of the Supervising Architect, Treasury Department, Washington, D. C. New York: Heating and Ventilating Magazine Co. Cloth; 6x9 in.; pp. xiv + 244; 105 illustrations. $3, postpaid.

Suction-cleaning systems have come into vogue so rapidly that few engineers have had a good opportunity to familiarize themselves with the characteristics which should mark proper equipment for various services. So many different aggregations of apparatus are being marketed as "vacuum cleaners" and such diverse conditions in cleaning have to be faced that any engineer without special experience must be confused in selecting the system best adapted for his clients. Of the few who have been able to study suction cleaning closely and critically, none should have had better opportunity than the author to equip themselves for giving sound and useful advice to their less experienced brethren.

His presentation of the subject is largely historical but quite critical. He tells what devices have been developed and also what is the matter with them or what their limitations are. He quotes numerous tests which show relative degrees of suitability and efficiency, and he tangibly summarizes the results of his discussions in readily understood recommendations.

At first the history of mechanical cleaning in general is reviewed, beginning with the housemaid's humble friend, the old-fashioned carpet sweeper, running through the compressed-air schemes and all the early suction cleaners. Before describing the existing schemes in detail, the author digresses for a few pages to lay down the requirements of an ideal system—as a sort of yard stick by which the existing apparatus can be sized up. It is seen on a few minutes' thought that both effectiveness and efficiency of a suction-cleaning system depend much on the cleaning tool at the end of the suction line—the "renovator" the author calls it. Very many attempts have been made to get better designs for this and that service and the author takes them up critically one by one. The other parts of the system—stems and handles, hose, pipe and fittings, separators and vacuum producers, are similarly handled.

There is a peek into the future given by an interesting chapter on wet scrubbing systems. It appears that several

such schemes, combining water-supply and suction-removal lines with renovating and soaping tools, await only the education of the public to the advantages of simple dry suction cleaning before this further advance is sprung on them.

In the chapter on selection of apparatus there is much advice as to what to install under various conditions of large and small premises. Under "Specifications" and "Tests" are suggestions for getting the desired results.

In the final chapter the use of portable cleaners is discouraged as they are "little better than carpet sweepers." However, for those rented premises where no permanent cleaning installation is possible the author lays down test requirements which should be satisfied; these will best be secured with apparatus which is moved with difficulty rather than with that which is easily portable.

A New Edition of Guldner's German Work on Internal-Combustion Engines

Reviewed by LIONEL S. MARKS*

DAS ENTWERFEN UND BERECHNEN DER VERBRENNUNGSKRAFTMASCHINEN UND KRAFTGAS-ANLAGEN—Von Hugo Güldner, Maschinenbaudirektor, Vorstand der Güldner-Motoren-Gesellschaft in Aschaffenburg. Third edition, revised and enlarged. Berlin: Julius Springer. Cloth; 8x11 in.; pp. xx + 800; 1282 text figures and 235 tables. 32 Marks.

A new edition of Güldner's book on the construction and design of internal-combustion motors is an event of importance in the gas-engineering world. Since the appearance of the first edition in 1902, this book has been universally regarded as the foremost authority in the German-speaking countries and has been largely used by engineers of all countries. The first edition was reviewed in these pages ("Eng. News," May 14, 1903) by the late Prof. Storm Bull, who said: 'It does not seem that there can be any question but that the above book is the best reference work on gas, gasoline and oil engines which has yet been published in English, French or German." The same can be said with equal truth of this new edition.

In the interval since the second edition, in 1905, the principal change in the gas-engine situation in Germany has been in the development of the Diesel engine, which has now come into wide use as a result of the lapse of the fundamental patent. That development has been quite phenomenal so that at the present time the Diesel engine contests with the Otto cycle engine the supremacy among stationary internal-combustion motors in Germany. This great growth of the Diesel engine has changed the relative importance of gas-engine topics to such an extent as to necessitate a complete rewriting of the older edition. It has, moreover, brought so much additional material as to require a notable compression of the earlier material in order to prevent an undue increase in bulk. As it is, in the new edition the number of pages has increased from 620 to 820; the tables from 143 to 200; the figures from 800 to 1285; and the double-page "construction" drawings from 30 to 35. The new edition is in five parts, dealing with gas-engine processes (52 pp.); detailed construction and design (392 pp.); fuels (26 pages); combustion (26 pages); and the construction and economic performance of modern engines (131 pages). Three long appendices give, respectively, the historical development of the gas engine (102 pp.); physical and chemical theory and data (28 pages); and a code for testing, installation, fire protection, etc. (36 pages).

The general character of the book has not changed. It is still a work primarily for the designer. It contains a great wealth of excellent detailed drawings of parts, of assembled drawings of complete machines and of tables of performance, as well as the fundamental theory that is necessary in design. It is written by a man who has built many engines of various types and who shows, both in his designs and in his book, much sagacity and special knowledge. It is undoubtedly the most complete compilation of detailed information on gas-engine construction and operation that is available at the present day.

In turning over its pages one's interest is naturally attracted first to the treatment of the Diesel engine. As an indication of the completeness with which this subject is handled, it is interesting to note that the Diesel engine accessories alone occupy 25 pages, of which 10 are devoted to the oil pump, 9 to the air compressors, and 6 to the oil-admission valves. The treatment of the air compressors includes, among other things, data from many tests on the indicated power in the air cylinder and on the power required to drive the compressor, and the actual dimensions of ma[illegible]gines. In addition, there are given detailed drawings of [illegible] different designs of air compressor.

Equally generous space is given to the discussi[illegible] general engine details. For example, piston rods and [illegible]sheads occupy 27 pages; crankshafts, 45, and valves and [illegible]gears, 44. It is rather surprising, on turning to the sub[illegible] gas-producers, to observe that the whole treatment of [illegible]tion of gas-producers occupies only 16 pages, gas cle[illegible] two p[illegible]ges, and the purification of the cleaning water, [illegible]pages. The treatment of this topic, although excellent so[illegible] as it goes, is apparently not intended for the designer [illegible]e are some other matters also in which the treatment [illegible]ot as complete as might have been anticipated.

The use of alcohol as an engine fuel is not touched upon except in the section on fuels, where its properties are given. We have been hearing, for a number of years, of the importance of that development in Germany and of the probability of alcohol taking the place of gasoline as the latter fuel became more expensive, but there is no indication of any such process in this book. Some recent developments in Germany are not touched upon. Prof. Junger presented to the American Society of Mechanical Engineers, in December, 1913, a paper on the present status of the large gas engine in Europe, and dwelt upon a number of devices which have been tried out in Germany with success and which seem to open the doors to increased capacity or economy. Among these devices was the method of increasing the output of large engines by slight pre-compression of the charge, and the method of "hot-cooling" of the cylinder walls by cooling with water, under pressure, at a temperature exceeding 212° F. These matters are not discussed at all. The author seems to have it in mind to give only well established practice and not to take up new matters, however promising they may be.

Such condensation as has been carried out has been well done. It has taken place mostly in the historical section. It would seem, however, possible to condense other parts of the book without seriously reducing its value. There are occasional lengthy quotations from papers by various authorities which might well be replaced by a condensed statement of the contents of those papers. Certain controversial matters on stratification in gas engines and on the phenomena of slow combustion have been retained, although those matters are no longer of any practical importance or have been fully settled to the satisfaction of everyone concerned. It is undoubtedly true, however, that the reverberations from such ancient discussions last longer in Germany than here; but they must be dying down by now.

It is doubtful whether the many excellent assembled drawings of machines and the photographs of engines installed are of sufficient value to justify their inclusion. Photographs might certainly be omitted without any loss to the designer and the reviewer is inclined to think that the same is true of many of the double-page drawings.

It is ungracious to cavil at these matters in so excellent a work. The reviewer's chief regret about the book is that it is not available in English for our own engineers. The excellent translation of the second edition by Prof. H. Diederichs (see "Eng. News," Mar. 17, 1910) should now be brought up to date as rapidly as possible in order that such information as is given on the Diesel engine should be more generally available.

*Professor of Mechanical Engineering, Harvard University, Cambridge, Mass.

WORK, WAGES AND PROFITS—By H. L. Gantt. Second edition, revised and enlarged. New York: The Engineering Magazine Co. [Works Management Library.] Cloth; 5x8 in.; pp. 312; 27 text figures, 13 folding charts. $2, net.

Mr. Gantt has taken advantage of the appearance of a second edition of his well known "Work, Wages and Profits," to amplify a previous description of his methods of systematic factory management. The revision improves the unity of the original work which was really a compilation of earlier scattered contributions. The author now has added a chapter on task setting, amplified his discussion of encouraging industrious habits, cited more results in wider fields, and given a specific illustration of how his principles would be carried out in practice. Mr. Gantt takes occasion to caution the reader that mere rules and systems are vain reliances in the absence of real understanding of ends and efforts.

In this book is one man's solution for the pressing problem of high cost of living. If the multitudes in this country who suffer from this adverse economic condition could understand that much blame is on a growing inefficiency of labor and the consequent increasing unit cost of production, there would be little opposition to the work and wage reforms which Mr. Gantt and his colleagues would gradually establish.

Revision of Stansfield's Electric Furnace

Reviewed by F. A. J. FITZGERALD*

THE ELECTRIC FURNACE, Its Construction, Operation and Uses. By Alfred Stansfield, Birks Professor of Metallurgy in McGill University. Second edition, revised, enlarged and rewritten. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xiii + 415; 155 illustrations. $4, net.

In his preface to the new edition of his book, Professor Stansfield says that "care has been taken to include as far as possible all recent developments of importance, but . . . . . it has been difficult to bring each part as closely uptodate as is desirable." Anyone familiar with electric-furnace progress will readily appreciate the difficulty mentioned by Professor Stansfield and it may certainly be said that he has met it with great success, for he has evidently followed the literature of electric furnaces closely since the publication of the first edition of his book in 1907 and does not appear to have missed much of importance. The book, therefore, can be recommended to readers who desire a comprehensive review of electric-furnace literature that is as recent as can be expected in a subject that in many ways is developing rapidly.

It is necessary to use a qualifying adjective in speaking of the development of the electric furnace for from one point of view it is disappointing to many. As Professor Stansfield remarks in his introduction, "the halo of romance, that has always surrounded electricity in all its forms, has caused the wildest schemes to be originated and has given them a hearing," and this perhaps is a reason why expectations as to the development of the electric furnace are somewhat unreasonable and result in the disappointment referred to above. A comparison, however, of the first and present editions of Professor Stansfield's book shows considerable development in six years. Thus, the present book is more than twice the size of the first edition, and this is due not merely to the new furnaces which have been developed or proposed since the first edition, but to the incorporation of much new work which has been done in relation to electric furnaces in general.

Passing over the first three chapters, devoted respectively to history, classification and efficiencies of electric furnaces, with an expression of regret that the author apparently likes that abominable mongrel unit known as the Calb, we come to the chapter on "Construction and Design." This covers a review of the various refractory materials used, or proposed for use, in electric furnaces; thermal conductivity; radiation and convection; resistors; electrodes and their holders. The literature on electric furnaces has evidently been carefully examined in the preparation of this chapter, but it can hardly be said that much useful instruction is given as to design. Some data are given, but for anyone who really needed instructions in the principles of design the chapter would be misleading. For example, he would be inclined to lay great stress on the calculation of electrodes by Hering's formulas and altogether overlook far more important considerations in the construction of his electrodes. It is not implied by any means that Hering's considerations are valueless, but they are only one of many which have to be kept in mind when designing a furnace and are not shown in proper perspective.

There is no consideration of the principles involved in the design of furnaces heated by resistors, as, for example, the furnaces used in the manufacture of silicon carbide, graphite, etc., and yet it is probable that furnaces depending upon the principles on which these are based will have a considerable development in the future. The beginner in electric-furnace construction is apt to make many mistakes in the construction of furnaces which depend upon the generation of heat in the electric arc, due to inadequate consideration of the principles involved, but the chance of mistakes is far greater when it comes to the construction of furnaces where the heat is generated by resistance pure and simple, and, therefore, this is a subject which would be well worthy of treatment in a book which dealt with the design of electric furnaces.

In considering "the operation of electric furnaces" the subjects dealt with are electrical supply, which merely covers a diagram showing method of regulating the voltage on the secondary of a transformer, wiring diagrams, and very brief mention of electric measurements; some calculations of the rate of production of heat per unit volume in various furnaces; voltages required by various furnaces; discussion of the pinch effect; some remarks on the regulation of power supply and the measurement of temperatures. So little really useful information has been published on this subject that much cannot be expected from this chapter.

The remainder of the book is devoted to the consideration of various uses of the electric furnaces. The subject is presented with a fair degree of completeness, but a somewhat more critical treatment would be valuable.

On the whole, the book forms an uptodate review of electric furnaces, and with its good index and plentiful references should prove useful.

*FitzGerald and Bennie Laboratories, Niagara Falls, N. Y.

Industrial Chemistry

INDUSTRIAL CHEMISTRY FOR ENGINEERING STUDENTS—By Henry K. Benson, Professor of Industrial Chemistry in the University of Washington. New York: The Macmillan Company. Cloth; 5x8 in.; pp. xiv + 431; 52 text illustrations. $1.90.

There is in this volume something on the chemistry of practically all the common materials of engineering work and some other things involved but not commonly thought of as materials of construction—air, water and fuels. Some of the topics—like fuels, combustion processes, iron and clay products, hydraulic cements and lime products—are given more space than the others—like lubricants, paving and painting materials, electrical insulation, cellulose and explosives. A small book on such a large subject necessarily can give readers only a limited knowledge of the ultimate nature of materials and processes. This inherent shortcoming the author aims to minimize by a bibliography of books and articles at the end of every chapter.

The presentation is clear and readable, and the selection of matter shows care and judgment. The work will seem unbalanced in a few spots to many readers, though this is not a serious matter. For instance: The author gives considerable space in one place to speculations about the organic or inorganic origin of petroleum but says nothing, in the section on iron and steel, about electric-furnace processes, which are assuming importance. There is under paints a presentation of the "carbon-dioxide," "hydrogen-peroxide" and "electrolytic" theories of iron corrosion but nothing on the very practical matter of accelerated tests for corrodability of samples, or on the technical advantages of combining crystalline and fumiform pigments.

The book opens with a few pages on handling materials, grinding, drying, calcining, fusing, distilling, filtering and similar processes. Next, the composition and sanitary properties of air, ventilation and heating, refrigeration, and fixation of nitrogen are taken up. A third chapter covers the sanitary and industrial aspects of water-supplies. The rest of the book takes up the other topics already referred to.

Electrical Engineering Problems

ELECTRICAL ENGINEERING PROBLEMS—Part I, Direct Current Circuits and Apparatus; Part II, Alternating Current Circuits and Apparatus. By F. C. Caldwell, Professor of Electrical Engineering, Ohio State University. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 105. $1, net.

PROBLEMS IN ALTERNATING CURRENT MACHINERY—By Waldo V. Lyon, Instructor in Electrical Engineering, Massachusetts Institute of Technology. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. ix + 136. $1.50, net.

Every teacher of electrical engineering knows the great need of practical problems in showing students the application of laws of action and methods of design. Not every one has the faculty of inventing good problems. An exchange of problems among teachers by the circulation of books like these two is an efficient way of keeping up the standards of instruction.

Prof. Caldwell covers a wide range—elementary circuit phenomena, power and work, magnetic actions, elementary machine design (both direct and alternating current), characteristics of alternating-current circuits, etc. He has also noted after each problem the normal time found necessary for its solution.

Mr. Lyon's problems are in a more restricted field and consequently are more complex for the most part. He states that they are such as he gives to fourth-year students. The contents naturally divides itself into a few main sections—on transformers, synchronous generators and motors, induction motors, rotary converters, polyphase circuits and non-sinusoidal waves.

YELLOW PINE: A Manual of Standard Wood Construction. Prepared and Compiled by Arthur T. North, Assoc. M. Am. Soc. C. E. Fourth Edition. St. Louis, Mo.: The Yellow Pine Manufacturers' Association, Geo. K. Smith, Secy., Wright Bldg. Paper; 4x7 in.; pp. 130; illustrated.

This valuable handbook contains tables of the strength of beams, grouping the timbers in terms of their depth; factors

for converting safe loads to other fiber stresses than the one on which the tables are based; deflection; tables of properties of actual size timbers, instead of nominal size timbers; tables of maximum bending moment, strength of wooden columns; tables for trussed beams; data concerning joists, trusses, nailed and spiked joints; tests of timbers, etc.

An Attack on Diesel

Reviewed by H. R. SETZ.*

DER DIESELMYTHUS: Quellenmassige Geschicte der Entstehung des heutigen Olmotors—Von T. Lüders, Fruher Professor an der Kgl. Technischen Hochschule zu Aachen. Berlin: M. Krayn. Paper; 6x9 in.; pp. 236; 12 text figures. 4.50 Marks.

The Dieselmyth represents the latest addition to a number of recent German publications pertaining to the history of the Diesel engine.

On Nov. 21, 1912, the late Doctor Diesel presented a paper before the annual meting of the Schiffsbautechnische Gesellschaft (Naval Engineers), in Berlin, treating on the evolution of the engine carrying his name, from its inception to the time when his first engine became a practical success. The substance of this lecture was presented to the members attending this meeting in the form of a manuscript, which later, with some modifications, was incorporated in the transactions of the society. In the discussion following the reading of this paper, Diesel was vigorously accused of overestimating the value of his personal work and of not giving due credit to his contemporaries. In April, 1913, one of Diesel's former associates, Prof. P. Meier, published a booklet, which, evidently induced by the discussion at the Berlin meeting, formed a valuable and tactful contribution to the matter under consideration. Shortly after this, in the summer of 1913, Dr. Diesel published the above-mentioned paper, again somewhat changed and enlarged, in book form. In the forward he claimed that this book was an authentic and exhaustive presentation of the evolution of his invention.

Lüders' book is based upon these publications as well as upon earlier writings on the Diesel engine in the technical press, mostly those by Diesel himself. The tone of Lüders' book can best be expressed by a somewhat free translation of a passage from the opening chapter, in which Diesel's work is reviewed and critically discussed in condensed form:

A myth is the product of tradition from generation to generation; in the case of Diesel this does not apply, however, since Diesel himself, by clever press propagation, has succeeded in creating a myth by building up a fictitious story around his work.

After the reader has thus been warned, Luders goes on to analyze Diesel's writing on the various phases of his work.

The vast mass of destructive evidence and criticism presented is a striking example of German thoroughness which in this case seems far more evident in the criticism than in the matter criticized. According to Lüders, Diesel's work bristles with superficiality and no credit whatever is due him for the creation of the engine bearing his name, except that by a succession of usurpations and blunders he has become the chief promoter of this new type of prime mover. Neither would his fundamental German patent of 1892, nor the often cited publication on "a rational heat motor" of 1893 disclose any features of novelty, as they merely cover a clumsy modification of a theorem which several years before had been laid down in the then most authorative German textbook on internal combustion engines by Koehler, with which Diesel must have been acquainted. A second patent, granted to Diesel in 1893, likewise fails to pass Lüders' critical pen, who shows that it is not, as Diesel would have it, the result of his experimental work, but covers a substance a suggestion which had been advanced at that time by Lüders himself in discussing Diesel's publication.

In analyzing the three versions of Diesel's account of his experimental work, which lasted from 1893 to 1897, Luders shows that Diesel did not proceed with the systematic and scientific endeavor which he claimed in his paper of 1912 and subsequent publications. Aside from having lacked the necessary practical knowledge to carry his work through expeditiously, his shifting to entirely different modes of operation would indicate little faith in what he claimed to be his invention. The final result of this period was an engine which differed entirely in every important feature from Diesel's original aspirations, although even in his latest publication he strenuously endeavored to maintain the opposite impression. More than that, the cycle of operation of this final Diesel engine was practically like what others, as Capitaine and Koehler, had anticipated long before Diesel.

This, in a general way, is the subject m[atter] of Lüders' lengthy treatise. The author has, as a wh[ole] succeeded in correcting a picture which, in the minds of th[e] initiated, had undoubtedly been an exaggerated one. Neverth[eless] it is to be hoped that his book will find few readers. It is written too much from the abstract standpoint of the [mathe]matician, whose principal interest centers in the thermodynam[ic] features of the engine. Thus, the writer cannot agree [with] the author that the adoption of a water-jacketed cylin[der] contributed chiefly to the final success of the Diesel engi[ne]. Mechanical problems of far more intricate nature, which [are] even today not clearly understood, had to be solved by p[ain]staking experimental work before the Diesel engine be[came] what it is today. The worst feature of Lüders' book, h[owe]ver, is the extremely unpleasant way in which the subject [is] treated. In spite of all his human faults and weaknesses, Diesel is after all entitled to more sympathy than Lüders is willing to accord him; if for nothing else than for the skill and aggressiveness with which he has founded and furthered a new industry, the limitations of which cannot even yet be foreseen. That Diesel possessed the highly developed sense of commercialism necessary to accomplish this result is only to his credit, and the last tragic episode of his life bears ample proof that he was not the one who benefited most by this faculty.

*Chief Engineer, Oil Engine Department, Fulton Iron Works, St. Louis, Mo.

Movable and Masonry Bridges

Reviewed by LEON S. MOISSEIFF.*

DER BRUECKENBAU: Lehr- und Nachschlagebuch für Studierende und Praktiker—Von M. Strukel, Professor an der Finnländ. Technischen Hochschule in Helsingfors. II Teil. Enthaltend: Bewegliche und Steinerne Brücken. Leipzig: A. Twietmeyer. Paper; 8x11 in.; pp. viii + 237; 330 text figures. 16 Marks.

The atlas of more than 40 plates which belongs with this book was published in the year 1906. The reviewer is pleased to find that in modern Germany there is extant that complacency of mind and imperturbability of business which permits the publication of drawings seven years before the printing of the explanatory text. This is almost paradisaic bliss. Engineering science of today, however, is so ill suited to such bliss, that the author had to include in his text a number of illustrations, telling of the later-day developments in the subjects treated.

The author devotes to movable bridges somes 40 pages, which contain mostly short descriptions of the drawings in the atlas and are merely enumerations of various built bridges of the movable types. The rest of the book treats of masonry bridges, including concrete and reinforced concrete. The treatment consists of a description of what has been done here and there and of the usual theoretical material furnishing the general analytical formulas for the computation of arched ribs. Rarely the author ventures his opinion. There is no distinction made between the good and the bad.

As a general description of masonry arches the book, one surmises, may have its value but in the absence of the prematurely born atlas of drawings this may be taken as an expression of optimism on the part of the reviewer.

THE LIGHTING BOOK: A Manual for the Layman, Setting Forth the Practical and Esthetic Sides of Good, Lighting for the Home—By F. Laurent Godinez. New York: McBride, Nast & Co. Cloth; 6x9 in.; pp. 109; illustrated. $1.25, net.

The illuminating engineer need not turn away from this title as indicating a superfluous addition to a well supplied literature; indeed the author is out with a club for the illuminating engineer—at least for the one who seeks efficiency rather than esthetic effect. Evidently the text has been written for a layman's perusal, for it will seem rather dilute on some elementary things in engineering, architecture and decoration.

First there are outlines of the physiology and optics of sight. Then the common evils of artificial lighting are exposed—over illumination in some places, under illumination in others, too high brilliancy of source, glare, poor color, etc. Prismatic glass shades come in here and there for strong condemnation of esthetic effect. In the rest of the book are presented some ways for diffusing and redistributing light and in general for improved utility and greatest decorative effect. The author displays a fondness for so called "indirect lighting" (reflection of rays from hidden sources)—a system which is generally considered to be pleasant and desirable, but, sometimes, tiresome in its unnatural novelty and mentally disconcerting because the source of the light is not

*Engineer of Design, Department of Bridges, Municipal Building, New York City.

obvious. A caution against the indiscriminate use of this system might well have been given.

The reader is well advised to seek for individuality in his lighting arrangements and the author points out various avenues for the exercise of originality.

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Laying Out Boilers

Reviewed by H. E. MOORE*

LAYING OUT FOR BOILER MAKERS AND SHEET-METAL WORKERS—A Practical Treatise on the Layout of Roll-ers, Stacks, Tanks, Pipes, Elbows and Miscellaneous Sheet-Metal Work. Second edition. New York: Aldrich Pub-lishing Co. Cloth; 10x13 in.; pp. 302; numerous text il-lustrations. $5.

An examination of the second edition of this book shows that it is very instructive. The book promises to be con-venient to manufacturers of plate work, estimators and drafts-men, as it gives the details of many different classes of in-struction which are not found in most books.

The work also promises to be handy for students as a reference work of practical examples in connection with de-scriptive geometry. The cuts are good. The size of the book appeals to the reviewer because it affords a chance to show the drawings on a large scale and to place most of the text referring to the figures on the same page as the figures themselves.

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THE FIELD ENGINEER'S HANDBOOK: A Handbook of Field Engineering for Civil Engineers and Engineering Students—By G. Carveth Wells, Assistant Lecturer and Instructor in Engineering Surveying at the City and Guilds (Engineering) College, Imperial College of Science and Technology, South Kensington, and Arundel S. Clay, Bramwell Medallist. New York: Longmans, Green & Co., London, England: Edward Arnold. Leather; 4x7 in.; pp. viii + 227; 79 text illustrations. $2.10, net.

The authors state that they "are fully aware that there are many excellent treatises on surveying, but which as handbooks for civil engineers, are quite unsuitable." This may be true in England, but it certainly is not true in this country, where there are several excellent surveyor's hand-books, compared with which the volume before us is neither better nor worse. It is an elementary treatise on surveying practice and railway location and construction, with a chapter on astronomy—such a book as has been a pocket-companion with American engineers since the days of Henck's "Field-Book for Railroad Engineers" (1854). This book also has the disadvantage of not having as many or as complete tables as the ordinary American "field engineer's handbook."

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COMMISSION REGULATION OF PUBLIC UTILITIES: A Compilation and Analysis of Laws of Forty-Three States and of the Federal Government for the Regulation by Central Commissions of Railroads and Other Public Utilities. New York: National Civic Federation, De-partment on Regulation of Interstate and Municipal Utilities, 1 Madison Ave. Cloth; 6x9 in.; pp. 1284. $8.50.

There has been need of some analytical compilation of the laws of the several states affecting public-utility regulation for heretofore, in seeking knowledge about any special point, it has been necessary laboriously to wade through the va-rious statutes. This need the National Civic Federation has satisfied—temporarily, no doubt, for as more states accept the commission-regulation scheme new editions may be needed. For instance, the new Illinois law is not here. The federal government and 44 states are considered. Matter has been included outside of the regulatory acts proper, where sim-ilarly affecting utilities. All this has been segregated under jurisdiction, organization, powers and practices of commis-sions, basis of rates, publicity, discrimination, service, safety, accounts, reports, franchises, stock and bond issues, intercor-porate relations, and enforcement of orders.

The nearest approach we have seen to this volume is a verbatim reprint of pertinent statutes by separate jurisdictions found in the 1912 "Journal of Proceedings" of the National Association of Railway Commissioners"—also a huge volume (see notice in "Eng. News," June 13, 1912, p. 1147).

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WELDING: Theory, Practice, Apparatus and Tests: Elec-tric, Thermit and Hot-Flame Processes—By Richard N. Hart. Second edition, revised, enlarged and reset. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xiv + 210; 127 illustrations. $2.50, net.

In reviewing the first edition of this book ("Engineering News," Jan. 19, 1911) we noted that the author has made a readable and very useful compilation of welding practice, in spite of a few omissions which prevented the book from being quite complete. The earlier work has now been rounded out by filling the most obvious gap (with a section on spot welding), though there still is chance to insert recent tests of smith welds and there is room for the discussion of smith-weld fluxes and foundry-cast welds—if indeed more can be secured in these lines. The notable progress made in elec-tric-arc and in oxygen-gas manipulations is reflected in the new pages. It is obvious from the foregoing that the revision has maintained the value of the first edition unimpaired and has even increased it.

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*With M. H. Treadwell Co., Inc., 140 Cedar St., New York City.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case ofbooks or papers privately printed, then to the author or other person indicated in the notice.]

AMERICAN ELECTRIC RAILWAY ENGINEERING ASSO-CIATION—Proceedings of Convention, Oct. 13-17, 1913. New York: H. C. Donecker, Secy., 20 W. 39th St. Cloth; 6x9 in.; pp. 673; illustrated.

THE AMERICAN YEAR BOOK: A Record of Events and Progress, 1913—Edited by Francis G. Wickware, under Direction of a Supervising Board Representing National Learned Societies. New York and London: D. Apple-ton & Co. Cloth; 5x8 in.; pp. xx + 892. $3.

ANNUAL REPORT OF THE MINERAL PRODUCTION OF CANADA, 1912—Ottawa: Department of Mines. Paper; 7x10 in.; pp. 339.

DER AUFTRIEB IN TALSPERREN—Von Dr.-Ing. Paul Fill-unger. [Pamphlet reprint.] Vienna: The Author. Paper; 6x9 in.; pp. 56.

A highly theoretical discussion of internal hydrostatic pressure in dams. Recommends regular pressure measure-ments in interior of dams to detect structural changes.

THE BACTERIA COUNT ON GELATIN AND AGAR MEDIA And Its Value In Controlling The Operation of Water Purification Plants—By James M. Caird, Chemist and Bacteriologist. Troy, N. Y.: The Author. Paper; 6x9 in.; pp. 29.

BRITISH COLUMBIA BUREAU OF MINES—Preliminary Re-view and Estimate of Mineral Production, 1913. By Wm. Fleet Robertson, Provincial Mineralogist. Victoria, B. C.: Bureau of Mines. Paper; 7x10 in.; pp. 35.

CONTINUOUS AND ALTERNATING CURRENT MACHIN-ERY: An Elementary Text-Book for Use in Technical Schools—By J. H. Morecroft, Assistant Professor of Elec-trical Engineering, Columbia University. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. [Wiley Technical Series.] Cloth; 5x8 in.; pp. ix + 288 text illustrations. $1.75, net.

COÖPERATION OF ENGINEER AND ARCHITECT IN CITY PLANNING—By Frank Koester, Consulting Engineer. [Address delivered before the International Congress on City Planning and City Maintenance, Ghent, Belgium, 1913.] New York: The Author, 30 Church St. Paper; 6x9 in.

THE CURRENTS IN THE GULF OF ST. LAWRENCE (From Investigations of the Tidal and Current Survey in the Seasons of 1894, 1895, 1896, 1906, 1908, 1911 and 1912.)—Ottawa, Can.; Department of the Naval Service. Paper; 7x10 in.; pp. 46.

DESCRIPTIONS OF LAND: A Text-Book for Survey Stu-dents—By R. W. Cautley, Late Surveyor to the Land Titles Office at Edmonton, Alta., and Member, Alberta and British Columbia Boundary Commission. New York: The Macmillan Co. Cloth; 5x8 in.; pp. 89. $1.

DETAILS OF CYANIDE PRACTICE—By Herbert A. Megraw, M. Am. Inst. M. E., Member of Editorial Staff, "Engineer-ing and Mining Journal"; author of "Practical Data for the Cyanide Plant." New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. vii + 215; numer-ous illustrations. $2, net.

DIE DRAHTSEILBAHNEN IHR AUFBAU UND IHRE VER-WENDUNG—Von Dipl.-Ing. P. Stephan. Second edition, revised. Berlin: Julius Springer. Cloth; 7x10 in.; pp. iv + 288; 286 illustrations. 9 Marks.

THE EFFICIENT MAN; For the use of all interested in the training of minors and development of supervisors to best manage men and work in commerce, manufacture, transportation and engineering, to decrease cost of pro-duction and living, and prepare man to best prolong his young-old years of servient labor and proficiency—By Thomas D. West, M. Am. Soc. M. E., Cleveland, Ohio: T. A. Gerblick, Sales Manager, 10,511 Pasadena Ave. Cloth; 5x8 in.; pp. 330; 28 illustrations. $1.50, post-paid.

ELECTRIC CAR MAINTENANCE—By Walter Jackson, Asso-ciate Editor, "Electric Railway Journal." New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. x + 275; 140 text figures. $3, net.

ELECTRIC TOY MAKING FOR AMATEURS—By T. O'Conor Sloane. Twentieth edition, revised and enlarged. New York: The Norman W. Henley Publishing Co. Cloth; 5x8 in.; pp. viii + 210; 77 illustrations. $1.

ELECTRO-THERMAL METHODS OF IRON AND STEEL PRODUCTION—By John B. C. Kershaw. With an Introduction by Dr. J. A. Fleming. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. xxiii + 239; 92 illustrations. $3, net.

FARM STRUCTURES—By K. J. T. Ekblaw, Associate in Agricultural Engineering, University of Illinois. New York: The Macmillan Co. Cloth; 5x8 in.; pp. viii + 347; 159 illustrations. $1.75, net.

FLOODS AND LEVEES OF THE MISSISSIPPI RIVER—By Benjamin G. Humphreys, Member of Congress from Mississippi. ["Copyright 1914 by the Mississippi River Levee Association, Memphis, Tenn."] Cloth; 7x10 in.; pp. 349. A compilation of various reports, addresses, testimony at hearings, opinions, etc., all designed to support proposed federal appropriations of $9,000,000 a year for five years for levee construction, the money to be used in conjunction with "an additional fund," contributed by local interests, "sufficient to complete the levee system."

THE FLOODS OF 1913 IN THE RIVERS OF THE OHIO AND LOWER MISSISSIPPI VALLEYS—By Alfred J. Henry, Professor of Meteorology. Washington, D. C.: Weather Bureau. Bulletin Z. Paper; 9x12 in.; pp. 117; illustrated.

DIE GEISTIGEN MITTEL DES TECHNISCHEN FORTSCHRITTES IN DEN VEREINIGTEN STAATEN VON AMERICA—Von Conrad Matschoss. [Pamphlet reprint.] Berlin: Verein deutscher Ingenieure. Paper; pp. 63. In reporting to the Verein deutscher Ingenieure on the ways and means of technical education and progress in the United States, Prof. Matschoss has made one of the most valuable contributions of recent years to American culture study. His descriptions are accurate, and his comments keen and fair.

HOW TO BUILD UP FURNACE EFFICIENCY: A Hand-Book of Fuel Economy—By Jos. W. Hays, Combustion Engineer; author of "The Chemistry of Combustion," "Combustion and Smokeless Furnaces," etc. Seventh edition, revised and enlarged. Chicago, Ill. (Rogers Park): The Author. Cardboard; 5x8 in.; pp. 126; illustrated. $1, postpaid to any part of the world.

HYDRAULIC MINE FILLING, Its Use in the Pennsylvania Anthracite Fields; A Preliminary Report—By Charles Enzian. Washington, D. C.: Bureau of Mines. Bulletin 60. Paper; 6x9 in.; pp. 77; illustrated.

ILLINOIS STATE MINING BOARD—Annual Coal Report for 1913. Springfield, Ill.: Martin Bolt, Chief Clerk. Cloth; 6x9 in.; pp. 279.

INSPECTION OF RAILWAY MATERIAL—By Morgan T. Jones, (Monadnock Block, Chicago). Paper; 3¾x7 in.; pp. 6.
A coöperative inspection department organized by the railways is proposed as a means of securing more efficient inspection of railway material. The matter was discussed in "Engineering News," June 5 and July 10, 1913.

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS—Proceedings of convention, New York City, Sept. 1-6, 1913. Roanoke, Va.: James McFall, Secretary. Paper; 6x9 in.; pp. 327.

LEVEE AND DRAINAGE LAWS OF TEXAS—Austin, Texas: State Reclamation Department. Bulletin 2. Paper; 6x9 in.; pp. 61.

MECHANICAL LABORATORY METHODS; The Testing of Instruments and Machines in the Mechanical Engineering Laboratory and in Practice—By Julian C. Smallwood, M. Am. Soc. M. E., Associate Professor of Experimental Engineering, Syracuse University. New York: D. Van Nostrand Co. Leather; 5x8 in.; pp. xiv + 333; 95 text illustrations. $2.50, net.

THE MINERAL RESOURCES OF THE PHILIPPINE ISLANDS, 1912—Manila: Bureau of Science. Paper; 8x11 in.; pp. 76; illustrated.

MINE SAMPLING AND VALUING; A Discussion of the Methods Used in Sampling and Valuing Ore Deposits with Especial Reference to the Work of Valuation by the Independent Engineer—By C. S. Herzig. With a Chapter on Sampling Placer Deposits by Chester Wells Purington. San Francisco: Mining and Scientific Press. London: The Mining Magazine. Cloth; 6x9 in.; pp. 163; 26 text figures. $2.

MINING AND METALLURGICAL SOCIETY OF AMERICA—Proceedings of annual meeting, New York City, Jan. 13, 1914 (including an interesting discussion of the relative merits of the hammer rock drill and the piston rock drill, and a paper by H. W. Rogers outlining the relative merits of the electric shovel and steam shovel). Bulletin 68, Jan. 31, 1914. New York: W. R. Ingalls, Secretary, 505 Pearl St. Paper; 6x9 in.; pp. 49.

MOLESWORTH'S POCKET-BOOK OF ENGINEERING FORMULA—By Sir Guilford L. Molesworth, Past President, I. C. E., M. I. Mech. E., and Henry Bridges Molesworth, M. I. C. E. Twenty-seventh edition, revised and enlarged, With an Electrical Supplement by Walter H. Molesworth, M. I. E. E. and I. Mech. E. London: E. & F. N. Spon. New York: Spon & Chamberlain. Leatherette; 5x3 in.; pp. viii + 936; numerous illustrations. $2.

NEW JERSEY'S RELATION TO THE PORT OF NEW YORK—Fourth Preliminary Report of the New Jersey Harbor Commission. Jersey City: Edward A. Ransom, Jr., Secretary, 75 Montgomery St. Cloth; 6x9 in.; pp. 214; illustrated.

NEW MEXICO GOOD ROADS ASSOCIATION, and the State Association of Highway Officials—Proceedings of meeting, Albuquerque, May 8 and 9, 1913. Albuquerque, N. M.: E. L. Grose, Secretary. Paper; 6x9 in.; pp. 128; illustrated.

PAPERS ON THE EFFECT OF SMOKE ON BUILDING MATERIALS—Edited by Raymond C. Benner. Smoke Investigation Bulletin 6, Mellon Institute of Industrial Research and School of Specific Industries. Pittsburgh, Penn.: University of Pittsburgh. Paper; 6x9 in.; pp. 58; illustrated.

PHYSICAL VALUATION OF RAILROADS—By William J. Wilgus. With Discussion by Messrs. Maurice [illegible], J. Frank Aldrich and others. [Paper 1287, reprinted from the Transactions of the Am. Soc. C. E., Vol. LXXVII.] Paper; 6x9 in.; pp. 203-345.

THE PRINCIPLES OF THE APPLICATION OF POWER TO ROAD TRANSPORT—By H. E. Wimperis, M. Inst. C. E., author of "The Internal Combustion Engine" and "A Primer of the Internal Combustion Engine." [Series of Six Lectures Delivered at the Technical College, Finsbury.] New York: D. Van Nostrand Co. Cloth; 5x8 in., pp. xii + 130; 134 text illustrations. $1.50, net.
This book, as originally published in England, was reviewed in our issue of Nov. 13, 1913, p. 1001.

PUBLIC SERVICE COMMISSION FOR THE FIRST DISTRICT of the State of New York. (New York, 154 Nassau St.)—Report for 1912, Vol. I. Cloth; 6x9 in.; pp. 301; illustrated.

PUBLIC SERVICE COMMISSION FOR THE SECOND DISTRICT of the State of New York (Albany, N. Y.)—Report for 1912, Vol. III, Abstracts of Reports of Corporations, Electrical, Gas, Telegraph, Telephone. Cloth; 9x12 in.; pp. 349.

PURE AND WHOLESOME WATER—By George A. Johnson. [Paper read at Minneapolis Convention, American Water Works Association, June, 1913.] Troy, N. Y.: J. M. Diven, Secretary of Association, 271 River St. Paper; 6x9 in.; pp. 59.

RAILROAD CURVES AND EARTHWORK—By C. Frank Allen, M. Am. Soc. C. E., Professor of Railroad Engineering, Massachusetts Institute of Technology. Fifth edition, revised. [Also in same volume, "Field and Office Tables" by same author. Revised edition.] New York and London: McGraw-Hill Book Co., Inc. Leather; 4x7 in.; pp. xi+226 and v+282; illustrated. $3, net; or separately, $2 each.

ROPE AND ITS USE ON THE FARM—By J. B. Frear. St. Paul, Minn.: University Farm, University of Minnesota. Bulletin 136, Agricultural Experiment Station. Paper 6x9 in.; pp. 76; 180 illustrations.

STUDIES IN WATER SUPPLY—By A. C. Houston, Director of Water Examination, Metropolitan Water Board, London. New York: The Macmillan Co. London: Macmillan & Co., Ltd. [Macmillan's Science Monographs.] Cloth; 6x9 in.; pp. xii + 203; 43 text illustrations. 5 shillings, net.

A TREATISE ON THE INSPECTION OF CONCRETE CONSTRUCTION, Containing Practical Hints for Concrete Inspectors, Superintendents, and Others Engaged in the Construction of Public and Private Works—By Jerome Cochran, Jun. M. Am. Soc. C. E., author of "A Treatise on Cement Specifications" and "The Principles of Municipal Refuse Collection and Disposal." Chicago, Ill.: Myron C. Clark Publishing Co. Cloth; 6x9 in.; pp. xv + 595; 23 text illustrations. $4.

U. S. BUREAU OF MINES—Washington, D. C. Paper; 6x9 in.; illustrated.
The Use and Misuse of Explosives in Coal Mining—By J. J. Rutledge, with Preface by Joseph A. Holmes. Miners' Circular 7. Pp. 52.
Metallurgical Coke—By A. W. Belden. Technical Paper 50. Pp. 48.
Metal-Mine Accidents in the United States During 1912—Compiled by Albert H. Fay. Technical Paper 61. Pp. 76.
Tests of Permissible Explosives—By Clarence Hall and Spencer P. Howell. Bulletin 66. Pp. 313.

U. S. GEOLOGICAL SURVEY—Washington, D. C. Paper; 6x9 in.; illustrated.
Thirty-Fourth Annual Report of the Director of the United States Geological Survey, For Fiscal Year Ended June 30, 1913. Pp. 183.
Contributions to Economic Geology, 1911; Part II—Mineral Fuels. Bulletin 531. Pp. 361.
Mineral Resources of Alaska; Report on Progress of Investigations in 1912—By Alfred H. Brooks and Others. Bulletin 542. Pp. 308.
Bibliography of North American Geology for 1912, with Subject Index—By John M. Nickles. Bulletin 545. Pp. 192.
Results of Spirit Leveling in Indiana, 1897 to 1911, inclusive. Bulletin 555. Pp. 51.
The Mud Lumps at the Mouths of the Mississippi—By Eugene Wesley Shaw. Professional Paper 85-B; 9x12 in.; pp. 27.

U. S. MORTALITY STATISTICS, 1911: Twelfth Annual Report—Washington, D. C.: Bureau of the Census. Cloth; 9x12 in.; pp. 572.

VENTILATION AND HUMIDITY in Textile Mills and Factories—By Cecil H. Lander, Lecturer in Civil Engineering, University of Manchester. New York and London: Longmans, Green & Co. Cloth; 5x8 in.; pp. viii + 175; 54 text illustrations. $1.40, net.

THE WATER SUPPLY OF COUNTRY HOUSES—By Dr. William Paul Gerhard. Paper; 5x7 in.; pp. 51; illustrated. 40c.
A 1914 reprint of an article published in 1907 by "The Review of Reviews."

WISCONSIN RAILROAD COMMISSION—Opinions and Decisions, Vol. IX, Mar. 13 to Aug. 22, 1912. Vol. X, Aug. 23 to Nov. 13, 1912. Madison, Wis.: J. M. Winterbotham, Secretary. Cloth; 6x9 in.; pp. 673 and 886.